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**Vegetative Propagation of Conifers**

BY

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# VEGETATIVE PROPAGATION OF CONIFERS

CARL G. DEUBER

## INTRODUCTION

Improvement in methods of securing superior planting stock for reforestation is advancing along three major lines as the transition from simple extractive forestry goes forward. These are: (1) knowledge and control of the source of the seed; (2) tree breeding; and (3) vegetative propagation. The results of the indiscriminate use of seed of unknown source became evident in Europe and America many years ago. Emphasis of the need for careful selection of the seed source has been made by Baldwin and Shirley (1936) and many others with good effect. Tree breeding projects as described by Austin (1927), Johnson (1939) and others are being conducted at various forest experiment stations and botanical gardens. The ultimate improvements to be attained by selection and breeding are well illustrated with short cycle crop plants; but the difficulties in procedure are greater with trees, and relatively long periods are involved before the results can be evaluated. The third method, vegetative propagation, has been employed by horticulturists for centuries to bring about standardization of many types of plants and rapid multiplication of individuals possessing chance combinations of superior characters. Varieties of fruit trees have been most generally propagated by budding or by grafting, but many ornamentals are readily propagated by cuttings consisting of pieces of the root or stem and, in some cases, of leaves. The present article emphasizes the importance of vegetative reproduction in the case of conifers.

The significance of asexual propagation in forest improvement was set forth at some length by Larsen (1936, 1937). With species in which successful cuttage practices are well established it is possible to multiply rapidly and economically large numbers of trees possessing desirable characteristics of form, structure and rate of growth. Or, it is possible to select for such specific qualities as resistance to certain diseases, immunity to serious insect pests, or the ability to withstand extreme cold or drought. These

and many additional features are recognized as having a basis in the combination of hereditary characteristics of the parent trees, and are continued in the asexually regenerated progeny. Vegetative propagation makes possible the establishing of plantations composed of the offspring of trees specially selected for the production of seed. Such plantations could be used as producers of high quality seed and for controlled genetic studies. It would also be possible to perpetuate vigorous hybrid strains.

With many species cuttage is practical with seedling to mature age classes, and over one or more seasons every year, thus avoiding the uncertainties of seed crops. Larger planting stock of some species can be obtained in fewer years through the selection of cuttings of appropriate size. As yet, however, the method of vegetative propagation of trees, has been but little used by foresters.

Intensive studies of the possibilities involved are underway in Canada by Grace (1939); in Australia by Jacobs (1939); and in the United States by Snow (1938), Thimann and Delisle (1939), Deuber and Farrar (1940), and others. These investigators have been working with single species or groups of related species. The techniques and the requirement for greenhouse culture are familiar to the horticulturist but not to the forest nurseryman. The costs of producing planting stock by means of cuttings will be higher than with seedling reproduction, but the higher quality and more uniform stock can offset this disadvantage.

The possibilities of the clone—the progeny of single trees—have been set forth by Schreiner (1939). Hartley (1939) has cautioned against the danger resulting from too great a uniformity in tree planting stock derived from extensive plantings of a single clone. Examples were cited among clonal varieties of ornamental, fruit and forest trees and crop plants that have proved susceptible to particularly virulent strains of parasites which spread rapidly through considerable populations of the uniform hosts. To secure the benefits of selected superior strains in trees where long life is essential, it is logical to recommend the employment of a mixture of clones to simulate the best features of the original forests.

Serious obstacles to the wider employment of vegetative propagation of forest trees are a lack of knowledge of the regeneration characteristics of many important species and the recognition of the fact that some species are exceedingly difficult to root from cuttings. Chief reliance must be had in the development of suc-

cessful techniques for rooting stem cuttings, as the various forms of grafting, applicable to fruit trees, are not suited to economical mass production of forest planting stock.

The most common form of natural asexual reproduction is the production of stump sprouts by various hardwoods, which makes possible the coppice system of silviculture. The sprouting of conifers is much less in evidence but occurs with redwood (*Sequoia sempervirens*), pitch pine (*Pinus rigida*) and shortleaf pine (*Pinus echinata*). Layering, the formation of roots from a portion of a stem covered with soil or moist litter, is known to occur with species of *Pseudotsuga*, *Larix*, *Thuja*, *Chamaecyparis* and *Cryptomeria*. Cooper (1931) described the layering habit of Sitka spruce and two western hemlocks, and called attention to the importance of this habit in the establishment of forests on bare granite areas. An isolated case of layering was reported for eastern white pine by Lutz (1940).

Knowledge regarding vegetative propagation of conifers that root more or less readily from cuttings has been largely confined to ornamental forms useful in landscape plantings. These include species of the following genera: *Taxus*, *Thuja*, *Juniperus*, *Chamaecyparis* and *Cupressus*. But slight information has been available on successful cuttage practice with most of the important forest species of *Pinus*, *Picea* and *Tsuga*. Detailed studies of one or more species of conifers have been conducted recently with *Picea abies*, Grace (1939, 1939a, 1939b, 1940, 1940a); and Deuber and Farrar (1939, 1939a, 1940); with *Pinus radiata* by Jacobs (1939); with *Pinus strobus*, *Picea abies*, *Picea pungens* and *Tsuga canadensis* by Thimann and Delisle (1939); with *Pseudotsuga taxifolia* and *Picea sitchensis* by Griffith (1940). This current interest in the vegetative propagation of some of the conifers provides a sound experimental foundation that is not only clarifying the principles concerned in the successful handling of these few species but may lead to knowledge of vastly wider application.

Experience has shown that some species, and even varieties of the same species, regenerate roots more readily than others. The cause of this difference in behavior is not yet clearly understood. It may be due to differences of structure, organization and physiology, to changes occurring with the seasons and with age, or to the influence of external conditions. The regeneration of roots from a piece of stem involves a series of physiological,

anatomical and morphological events as yet but partially understood. The internal developments are influenced by environmental conditions, and it is necessary to evaluate the importance of these conditions to achieve a measure of control over the initiation, organization and development of the primordia giving rise to roots. The present investigation has been largely concerned with detailed studies of cuttings of *Picea abies* and *Pinus strobus* from trees of young and old age classes, from trees in different plantations, collected throughout a year and placed under various propagating conditions and given various physical and chemical treatments. Less extensive studies were made of the rooting of cuttings of *Pinus resinosa*, *Pinus bungeana*, *Pinus densiflora* and *Tsuga canadensis*.

The author wishes to acknowledge the very capable assistance of Mr. Jesse G. Ralston with the experimental work during the fall-winter season of 1939-1940.

## GENERAL METHODS OF PROCEDURE

Propagation of the cuttings was conducted in a large greenhouse divided into two heated rooms, an unheated end-room and a preparation room. The long axis of the greenhouse was east to west, giving particularly favorable benches for propagation work along the benches on the north side. A lath shade covered the roof on the south side. Weathered muslin curtains were hung on wires in front of the benches to reduce the intensity of the direct sunlight when desirable. Additional shading of the benches was secured in the summer with muslin three feet above the cuttings. Also during the summer, use was made of a double outdoor cold-frame shaded on the top and sides with muslin curtains.

TABLE 1.

Mechanical analysis of the sand used in the propagating benches.

Class of separates	Size of particles, diameter—mm.	Per cent. on basis of oven-dry weight
Fine gravel .....	2.0 —1.0	20.8
Coarse sand .....	1.0 —0.5	42.7
Medium sand .....	0.5 —0.25	27.2
Fine sand .....	0.25—0.10	8.4
Very fine sand .....	0.10—0.05	0.7
Silt and clay .....	less than 0.05	0.2

*The Propagating Medium.* Sand was used as the propagating medium in the tile-bottomed benches in all but a few special tests of the suitability of peat and of a mixture of peat and sand. A very clean, sharp-angled, medium-coarse plasterer's sand was secured from a sand pit under water. The mechanical analysis of this sand, Table 1, shows that it contained principally coarse and medium size sand particles with a very small amount of silt and clay. The physical characteristics of this sand made it convenient to handle. The cuttings of many species produced excellent root systems in this sand. One hour after thorough watering the moisture content of this sand at the level of the planted cuttings was 14.5 per cent. of its oven-dry weight. Twenty-four hours later the moisture content was 11.5 per cent. The sand was neu-



tral in reaction. Cuttings that rooted promptly were rarely infested with fungi.

*Humidity.* The humidity and temperature of the greenhouse were regulated by hand.<sup>1</sup> It was early recognized that white pine cuttings, especially the larger sizes, dried rapidly when placed in the open benches. Therefore the early morning sprinkling of the benches was supplemented with two to four additional sprinklings of the walks and shade curtains. During January shallow pans of water were placed on the steam pipes and for a time a fine spray of water was directed over the steam pipes at two points in the main room. By these means it was possible to secure average relative humidities of 78 to 88 per cent. and minimum readings on a recording hydrograph of 62 to 76 per cent. Relative readings of Livingston spherical atmometers, placed in the preparation room, where no attempt was made to control the humidity, and in the main room of the greenhouse, were 14.6 and 7.0 ml. per diem, respectively, during January. In the cold room the average daily atmometer losses were 6.7 ml.

*Temperature.* The temperature in the main room during the winter months ranged between 66° and 76° F. most of the time. The temperature of the sand in the open benches was one or two degrees above that of the air temperature and did not fluctuate as much as that of the air. In the cold room one bench was equipped with a General Electric soil heating unit, one section of the bench being covered with a glass sash. The installation and operation of this type of heating unit are described by Wyman and Nixon (1934). In the cold room the air temperature during the greater part of the winter was between 45° and 60° F., but at times, for a few hours, especially at night, there was an extreme low temperature of 30° F. The sand in the electrically heated open bench in the cold room was 53° to 64° F. in December and January. In a sweat bench in the main room temperatures of 74° to 84° F., prevailed when the top sash was closed; and when the sash was open the sand in this compartment was two or three degrees above the temperature of the sand in the open benches.

In the summer period only the propagating bench along the north wall of the greenhouse was used. For the first few days

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<sup>1</sup> Acknowledgement is made of the excellent cooperation rendered in the management of the greenhouse by Messrs. J. H. and E. M. Murray and staff throughout this investigation.

after planting, the cuttings were heavily shaded with paper, and later by a light grade of muslin. In the completely shaded outdoor frame a nozzle yielding a fine spray was placed in the center. The cuttings were sprayed in the morning, at noon, and again later in the afternoon.

*Collection and Handling of the Cuttings.* With the exception of one exotic species of pine, lace bark pine, all the cuttings used in this investigation were collected from nurseries and plantations in and about New Haven, Connecticut.<sup>2</sup> The youngest parent stocks were seedlings two years old and the oldest trees 40 to 60 years old.

The major monthly collections, which consisted of 500 to 1200 cuttings, were made by two men who worked with pruning shears, a twelve-foot pruning hook and two large chip baskets. The cutting stock was brought in to the greenhouse, cut into suitable lengths, and planted directly in the propagating benches or started on the 24-hour treatments in solutions of chemicals during the same day. This rapid handling of the cuttings from the field to the propagating bench reduced the moisture losses to a minimum.

When making the large random collections of Norway spruce cuttings in a plantation of trees 40 years old, or of white pine cuttings in plantations of trees 25 to 40 years old, the more vigorous trees of the stand were selected. Stunted, suppressed and overtopped trees were avoided. The Norway spruce trees were of a height that permitted securing lateral branches directly with pruning shears at levels of four to eight feet; but the white pine trees had been pruned of all lower branches, and therefore required the use of a long pruning hook to secure branches for cuttings. The distal portions of three to five lower branches were taken from each tree.

At the greenhouse the cuttings were prepared by cutting twigs of the current growth near the union with two-year-old wood. With Norway spruce the cuttings ranged from 3 to 6 inches in length, and with white pine 2 to 5 inches. In several special series data were secured on the comparative suitability of small

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<sup>2</sup> Thanks are due to Professor Ralph C. Hawley for permission to collect cutting stock on the Eli Whitney Forest of the New Haven Water Company; to the Yale University Bureau of Planting; to the Cheshire Nursery; and to the Bartlett Tree Research Laboratories, North Stamford, Conn., where the lace bark pine cuttings were secured.

and large cuttings of white pine. The cut at the base of the cuttings was made horizontally with pruning shears. During the summer and early autumn the needles on the basal third of the white pine cuttings were trimmed off to reduce transpirational losses. Later this practice was discontinued.

The cuttings of a large random series were thoroughly mixed before being divided into lots for the various treatments. Control series and those treated with talc or charcoal dusts were planted immediately. The recently watered sand was firmly tamped with a brick, marked off in rows two inches apart and a groove 3 to 4 inches deep made with a piece of plate glass to receive the cuttings. Approximately one-fourth to one-third of the cutting length was placed in the sand and the sand tamped around the bases of the cuttings. This was followed by thorough sprinkling to settle the sand around the cuttings. These details assured firmly planted cuttings in close contact with the moisture in the sand during the important initial period of establishment.

*Preparation of Chemical Solutions and Dusts.* Numerous tests were made of the efficacy of various chemicals known to possess root-inducing properties. Sixteen of these chemicals were described and tested by Zimmerman and Wilcoxon (1935), and since then additional physiologically active compounds have been reported, such as  $\alpha$ -naphthylacetamide and  $\alpha$ -naphthylthioacetamide by Stoutemeyer (1939). The most numerous tests were with  $\beta$ -indolylbutyric acid, hereinafter referred to as indolebutyric acid and abbreviated to I.B. A sample of this chemical was obtained from Doctor R. H. Manske of the National Research Council Laboratories, Ottawa, Canada. Tests were made with  $\beta$ -indolylacetic acid, indoleacetic acid, abbreviated to I.A., from Merck & Company, Rahway, New Jersey; with  $\alpha$ -naphthaleneacetic acid from Merck & Company; and with  $\alpha$ -naphthylacetamide from the American Chemical Paint Company, Ambler, Pennsylvania.

Both solution and dust treatments were tested. To make the solutions a concentrated stock solution of the chemical was prepared with 95 per cent. ethyl alcohol and stored in a refrigerator. One day previous to the time when the cuttings were to be treated the required concentrations of the chemical were prepared by making the necessary dilutions with tap water. The bases of the cuttings were placed in the solutions in shallow finger bowls for a period of 24 hours in the preparation room of the greenhouse.

The dust method introduced by Grace (1937) was extensively employed. The method described by Stoutemeyer (1938) for preparing talc dusts was followed in using talc and charcoal as carriers of the physiologically active chemicals. In addition, the commercial preparations Hormodin No. 1, No. 2 and No. 3, manufactured by Merck & Company, were used as well as Vitamone manufactured by the Westville Laboratories, New Haven, Conn. The physiologically active ingredient of Hormodin is understood to be indolebutyric acid and of Vitamone  $\alpha$ -naphthalenebutyric acid. The convenience of the dust method for treating cuttings recommends it whenever it is found to be effective. The bases of the cuttings were wetted, the excess moisture shaken off and the base of each cutting dipped into the dust, lightly tapped on the side of the jar and planted immediately in the sand.

In several tests with vitamin B<sub>1</sub> (thiamin chloride) one sample of crystals prepared by the Harris Laboratories, New York, N. Y., was employed and later a sample of Vitaforce pellets prepared by William H. Rorer, Inc., Philadelphia, Pa. A stock solution of the chemical was prepared and fresh solutions of the desired concentration made just before applying them to the sand flats containing rooted cuttings.

*Examination of the Cuttings.* The conifers as a class are known to be relatively slow in rooting so that the minimum time allowed to elapse before examining the stem bases was usually 90 or 100 days. Since it was early recognized that disturbing the cuttings of white pine had a distinct retarding effect on rooting and decreased survival, many of the white pine series of cuttings were left undisturbed for 150 to 180 days. Examination of the cuttings required careful digging to prevent breakage or loss of roots, especially in the early stages of rooting before much lignification of the root tissues had occurred. Data were secured on the number of cuttings rooted, the character of the roots, root length, callus formation, number of survivors, number dead and amount of fungus infestation. With white pine all the viable cuttings were replanted for subsequent observations.

## EXPERIMENTAL

The experimental findings for each species studied will be set down separately together with a discussion of the results obtained. In a concluding general discussion, facts common to the various species studied will be brought together as well as the rooting characteristics in which the species differ.

### NORWAY SPRUCE

Within the past two years much interest has been shown in published accounts of the rooting characteristics of various species of *Picea* but particularly of Norway spruce (*Picea abies* Karst.). Thimann and Delisle (1939), working with Norway spruce and *Picea pungens*, found that the age of the parent tree was an important factor in root regeneration, and that lateral shoots rooted more readily than terminal shoots. Also, that treatments with auxin were a distinct aid to the formation of roots. Grace (1939, 1939a, 1939b, 1940 and 1940a) contributed a number of findings with Norway spruce regarding the superiority of cuttings taken from lower branches over those from upper branches, the influence of the month of collection, and the effects of a variety of chemical treatments. Deuber and Farrar (1939, 1939a and 1940) found that Norway spruce cuttings from mature trees increased in their natural capacity to root from October to December, that long cuttings were superior to short cuttings, that a heel of old wood at the base of the cutting inhibited rooting, and that solution treatments with indolebutyric acid were not effective in inducing a greater rooting response than that obtained with untreated cuttings. Kirkpatrick (1940) lists seven ornamental varieties of *Picea* among the conifers that respond to standard treatments with solutions or powders containing indolebutyric acid. Griffith (1940) found solution treatments with indolebutyric acid more effective than indoleacetic acid for inducing the rooting of Sitka spruce. These contributions on the rooting characteristics of spruces constitute a larger body of scientific facts than has been accumulated for any other genus of conifers. They will make large scale vegetative propagation programs feasible.

*Seasonal Variation in the Natural Rooting Capacity of Norway Spruce Cuttings.* It is well known that the cuttings of various species differ in the season at which they root most promptly and vigorously. This has given rise to the classification of cuttings as *softwood* when collected in the summer and *hardwood* or *dormant* when taken in the winter. Apparently the best season to collect cuttings for the most effective rooting responses can be determined only by experiment. Graham (1934) in relating the contributions of the expert propagator, Laurence Baxter Stewart, stated that the latter had cuttings taken from plants every month of the year and had prepared charts to show the precise season at which the best and most speedy results were obtained.

The results of Deuber and Farrar (1939a and 1940) to the effect that untreated cuttings from Norway spruce trees 39 years old increased in capacity to root, from 32 per cent., when collected in October, to 89 per cent., when collected in December, indicated that the season of collection was an exceedingly important factor, if not the major factor, involved in successful cuttage practice with this species. In April, 1939, a year's program was outlined in which cuttings of Norway spruce were to be collected each month until March, 1940. This program was carried to completion. Each month a large random collection of cuttings was made in a 40-year old plantation and divided into a number of lots to study the influence of chemical treatments and other features. The methods for handling the cuttings were uniform and all cuttings were planted in the greenhouse. Some special series, to be described later, were placed in an outdoor frame during the summer.

When the first spring collection was made, April 21, 1939, active new growth of the buds had not started. In mid-May active growth of the shoots was in progress. By June 18, the new growth of lateral shoots was 2 to 4 inches long. From June to September cuttings were made of this new growth, as well as of the 1939 twigs plus the current growth. In June, the tips of some of the tender new twigs wilted slightly during the first day in the bench but became erect within a few days. In mid-July the new twigs were sufficiently lignified and hardened to give no concern when planted. In August, the maturity of the current season's growth was such that this class of cutting was used for the majority of the treatments. The survival and rooting data for

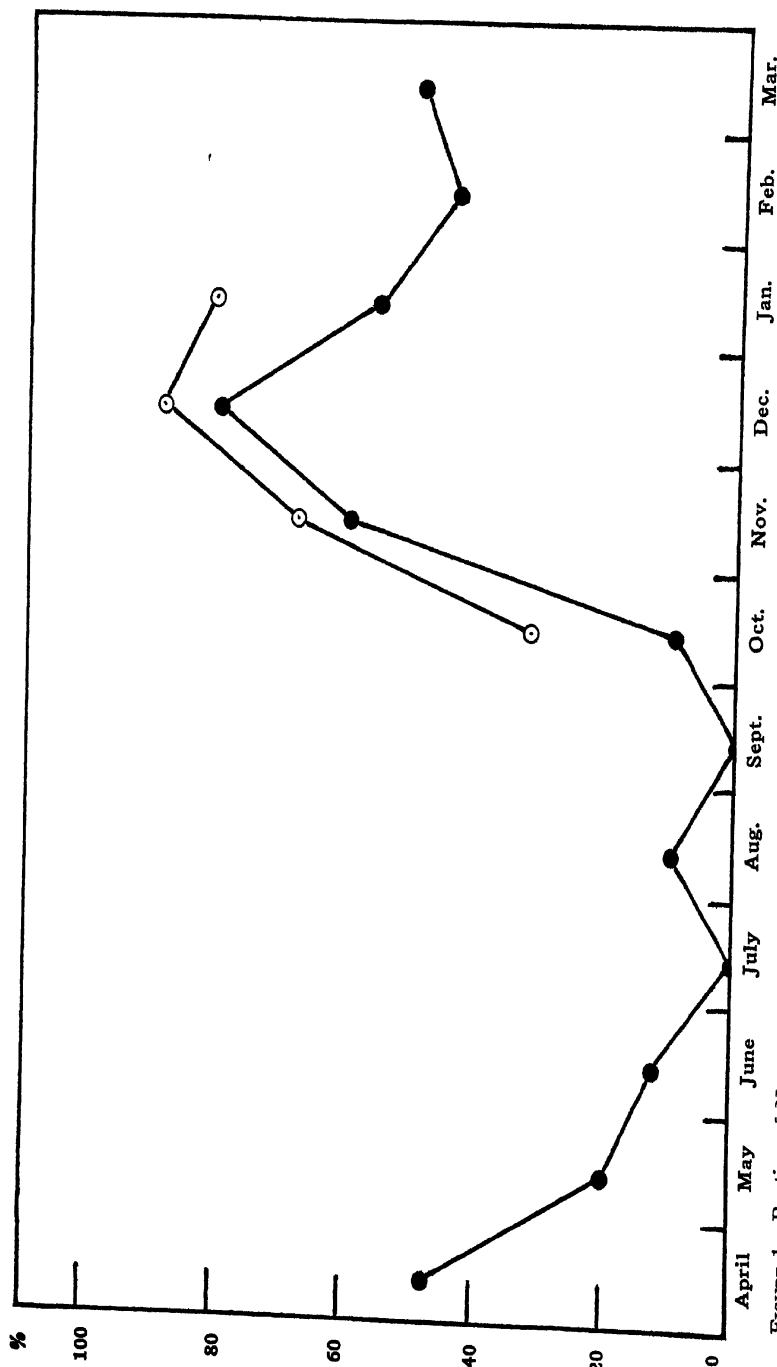


FIGURE 1. Rooting of Norway spruce cuttings collected at monthly intervals from October to January, 1938-1939, upper graph; and from April, 1939, to March, 1940, lower graph.

the spring to autumn collections covering the transition from hardwood to softwood cuttings are summarized in Table 2. The lower graph of Figure 1 shows the rooting percentages of the untreated control cuttings for 12 months. The data for the four months, October to January, 1938-1939, in the previous study by Deuber and Farrar (1940) are represented by the upper graph.

In sand and under the conditions of this experiment Norway spruce cuttings survived very well in all but the summer period. This applies to early rooted as well as non-rooted cuttings. Even cuttings with some rotting of the basal stem and of basal needles maintained the terminal bud and needles above the sand in an

TABLE 2.

Survival and rooting percentages of Norway spruce cuttings made from 1938 or 1939 twigs collected at monthly intervals from trees 40 years old. In propagating bench 100 days.

Month collected	Cuttings of 1938 twigs			Cuttings of 1939 twigs		
	No.	Surv.	Rooted	No.	Surv.	Rooted
		%	%		%	%
April .....	80	86.2	47.5	—	—	—
May .....	80	70.0	20.0	—	—	—
June .....	40	72.5	12.5	60	50.0	5.0
July .....	40	92.5	0	60	50.0	0
Aug. ....	50	98.0	10.0	40	90.0	22.5
Sept. ....	40	80.0	0	40	92.5	0
Oct. ....	—	—	—	40	95.0	10.0
Nov. ....	—	—	—	40	97.5	60.0

apparently healthy state for three or more months. When severe rotting of the base occurred with extreme desiccation or severe chemical injury, there was a reddening and drying of the needles, usually from the bud downward, followed by defoliation. Cuttings made from immature new wood in June and July survived to the extent of 50 per cent. in 100 days. Similar cuttings made in August survived to 92.5 per cent. No difficulty was experienced with failure of cuttings taken during the autumn and winter to survive. In December, January and February the terminal and upper lateral buds of many of the cuttings began to grow soon after being brought into the warm greenhouse. At this season the buds continued some development with or without the forma-



tion of roots. When a callus forms on the base of the cutting it is not conspicuous and is not easy to detect after rooting takes place.

The rooting capacity of the cuttings, collected during April, was definitely on the decline, reaching zero in material collected in July. In the August collections, cuttings of 1938 twigs rooted 10 per cent. and 1939 twigs 22.5 per cent. The significance of this limited rooting in August is not known. The September collections of both of these classes of cuttings failed to root. It was not until cuttings were taken in October that the "grand period" of rooting was inaugurated. The quality of the root systems in regard to number of roots, length of roots and amount of lateral branching showed marked improvement in cuttings collected from November to December and January. In February and March there was a decrease in the number of cuttings which rooted and also in the quality of the root systems formed.

*Influence of the Age of the Parent Tree upon the Rooting of Spruce Cuttings.* That the age of the parent tree has a definite bearing upon the rooting capacity of cuttings has become increasingly evident in recent years, as experiments in this method of propagation have progressed. In Goebel's (1900) account of regeneration of plant organs at different developmental stages it was observed that in certain conifers the juvenile form rooted more readily from cuttings than the adult form. Gardner (1929) found that cuttings taken from seedlings of a large number of tree species rooted much more readily than cuttings made from older trees. With cuttings from 2-year old Norway spruce seedlings the rooting was 90 per cent. and from trees listed as old, 50 per cent. White pine cuttings from 1-, 2- and 3-year old seedlings rooted 98, 51 and 12 per cent., respectively. In an extensive study of the vegetative regeneration of juvenile and mature forms of apple trees Stoutemeyer (1937) succeeded in rooting material that was in the youthful phase of growth. Many of the futile attempts to root cuttings of older apple trees were thought to be explained by the fact that the mature phase of growth of the tissues was not favorable for root formation. In a study of vegetative propagation of forest tree species by Thimann and Delisle (1939) the age of the tree from which the cuttings were taken was considered to be the most important single factor governing the ease with which rooting occurs. The percentage strike of roots fell off

steadily with increasing age of the tree. The rooting of Norway spruce seedlings three and four years old treated with water was 35 per cent., with auxin solution, 78 per cent. Cuttings from trees sixty years or over did not root with or without treatment with auxin.

During the course of the present study collections were made from time to time of cuttings from spruce trees 2, 5 and 26 years old, in addition to the monthly collections of cuttings from trees 40 years old. Since very young seedlings of Norway spruce were not available, 2-year old nursery stock of white spruce was used instead. The 5-year old Norway spruce had been transplanted

TABLE 3.

Rooting percentages of spruce cuttings from trees of four age classes.

Month collected	White spruce, age 2 years	5 years	Norway spruce, age:	
			26 years	40 years
	%	%	%	%
May .....	—	—	82.1	20.0
June .....	73.0	—	—	12.5
July .....	4.0	12.5	—	0
Aug. ....	—	—	—	10.0
Sept. ....	64.4	—	—	0
Oct. ....	100.	40.0	—	10.0
Nov. ....	92.5	—	—	60.0
Dec. ....	94.0	92.8	20.0	80.0
Jan. ....	90.0	—	—	56.0
Feb. ....	76.6	68.0	—	44.0
March .....	95.0	97.5	52.8	50.0

several years ago and was making vigorous growth. The 26-year old Norway spruce trees were marginal trees of a rapidly growing closed stand. The data of the latter are averages of individual tree collections to be discussed later. Data on the 40-year old trees are those used in the section treating the influence of season on rooting. The rooting percentages of cuttings from parent trees of the four age classes are summarized in Table 3.

From the data of Table 3 it is evident that the rooting response of cuttings from young spruce trees was considerably greater than the response of cuttings from older trees. This finding is in complete accord with previous reports on this and other species of trees. The cuttings from 2-year old white spruce seedlings rooted

exceedingly well in collections made from November to March. This seems to indicate that to a high degree and over a considerable period the internal conditions determining the natural capacity of these cuttings to root are present. Cuttings from seedlings were more prompt in producing roots than those from older trees, and in a given time longer and more abundantly branched roots were produced. Typical root systems of cuttings from seedlings are illustrated in Figure 1, Plate I; and of cuttings from older trees in Figures 2, 3, and 4, Plate I and Figures 1 to 4, Plate II.

While rooting data through a whole year are not available for the cuttings from seedlings, the operation of a seasonal factor influencing the rooting of these cuttings appears evident. In June, cuttings were made of 1-year old lateral twigs with the current new growth. The new shoot growth of many cuttings dried out rather soon and survival at the end of the propagation period was only 30 per cent. In July, the majority of the seedling cuttings rotted and dried out with but 4 per cent. rooting. Another lot in July treated with dust containing 1 mgm. of indolebutyric acid per gram of talc survived somewhat better, but the rooting was but slightly improved—6 per cent. After a medium rooting response of 64.4 per cent. with seedlings collected in September, the rooting of cuttings collected in October and the winter months was of a high order.

The magnitudes of the rooting responses of the cuttings from transplanted 5-year old Norway spruce trees follow those of the cuttings from seedlings rather than those from older trees. In July, when the control lot rooted 12.5 per cent., two lots treated with 1 and 4 mgms. of indolebutyric acid per gram of talc, respectively, rooted 27.5 per cent. in each case. This was one of the greatest increases in root production found with any chemical treatment of Norway spruce cuttings. From the tests made with cuttings of the 5-year old transplants low rooting responses were recorded in midsummer and early fall but a sharp rise occurred during the winter months. Prompt rooting and the formation of four to six long roots well supplied with laterals were characteristic of the cuttings from 5-year old trees taken during the winter season.

The data for the rooting of cuttings from 26-year old Norway spruce trees are based on collections of cuttings from individual

trees in a study of clonal variation. For the present purpose the averages of the rooting responses of the cuttings of all the trees in a given collection were employed. In the May collection the rooting percentage is based on 520 cuttings from 7 trees, and in the March collection on 180 cuttings from 9 trees. Of considerable interest is the fact that cuttings collected in May rooted very well (82.1 per cent.) while those taken in December gave an average rooting response of only 20 per cent. These responses differed from the seasonal trend found for cuttings of both younger and older age classes. A discussion of these results will be made in the section dealing with clonal variation.

The seasonal aspects of root regeneration by cuttings of trees 40 years old have been discussed in the previous section. It will be noted that from a period of very slight rooting in cuttings collected in the summer a rapid increase in the rooting capacity occurs from October to December with decrease in rooting from January through the spring months. Cuttings from these older trees did not root as promptly as those from young seedlings or transplants, fewer roots were formed and fibrous roots were produced much later and less abundantly. However, cuttings made in December, January and February had root systems of good quality for transplanting in the outdoor nursery early in the spring. Plantings of similar cuttings in the spring of 1939 have survived satisfactorily through two summers and one winter and are in a vigorous state of growth.

*Influence of Chemical Treatments upon the Rooting of Norway Spruce Cuttings.* Long ago Sachs (1882) made the suggestion that the formation of roots in cuttings might be explained by the assumption that in the shoots a specific inducing substance was formed. The subsequent history of attempts to discover the existence of a root-forming substance passed through a number of phases in which it was recognized that the presence of buds in particular and of leaves to a lesser extent exerted a correlation influence in root formation. The growth substance concept of Went (1927) and others has greatly stimulated this search for specific substances, hormones, produced in various organs of plants and controlling different aspects of growth in other parts. Thimann and Koepfli (1935) and Kögl (1935) demonstrated that auxin b and the synthetic heteroauxin (indoleacetic acid) were active in the induction of root formation. It is now known from

numerous investigations that physiological activity to initiate the formation of roots is a property of many chemical compounds. Some of these compounds possess much greater physiological activity than others. Indolebutyric acid and indoleacetic acid have been more widely used in practical plant propagation than other compounds.

In a previous study of dormant cuttings of 39-year old Norway spruce trees Deuber and Farrar (1940) found that treatments with

TABLE 4.

Rooting percentages of Norway spruce cuttings from trees 40 years old after 100 days in the propagation bench, showing the effects of chemical solution treatments. Control specimens were planted directly in sand. All the other specimens were treated 24 hours in water or in aqueous solutions of indolebutyric acid with the exception of the February collections which were treated with solutions of indoleacetic acid.

Month collected	Con- trol	Water	Concentration of the chemical—mgms. per liter								
			0.3	0.6	1.2	2.5	5.0	10	25	50	100
	%	%	%	%	%	%	%	%	%	%	%
April .....	47.5	40.0	55.0	52.5	55.0	60.0	52.5	50.0	—	—	—
May .....	20.0	12.5	10.0	10.0	10.0	10.0	12.5	12.5	—	—	—
June .....	12.5	5.0	2.5	5.0	7.5	17.5	15.0	10.0	—	—	—
July .....	0	0	0	5.0	0	2.5	2.5	0	—	—	—
Aug. ....	22.5	—	—	—	—	—	—	—	—	—	—
Sept. ....	0	—	—	—	—	—	—	—	—	—	—
Oct. ....	10.0	5.0	2.5	—	—	7.5	—	0	—	—	0
Nov. ....	60.0	35.0	10.0	—	—	30.0	—	30.0	—	—	0
Dec. ....	80.0	77.5	65.0	—	—	70.0	—	65.0	—	—	37.5
Jan. ....	56.0	36.6	43.3	—	—	26.6	—	20.0	—	—	16.6
Feb. ....	44.0	—	—	—	—	—	47.5	45.0	25.0	2.5	—
March .....	50.0	—	—	—	—	—	15.0	12.5	20.0	12.5	—

a series of concentrations of indolebutyric acid did not increase the number of cuttings producing roots. This applied in October when natural rooting was low as well as in December and January when rooting was relatively high. Additional information was desired on the effectiveness of chemical treatments for Norway spruce cuttings, especially in the seasons when the natural capacity to root was low. From April, 1939, to March, 1940, a monthly program of chemical treatments of cuttings was carried on. Lots of 40 cuttings each were treated for 24 hours in solutions of indolebutyric acid or of indoleacetic acid, and similar lots were treated with indolebutyric acid mixed with talc or charcoal.

In view of the numerous data secured the results with the solution and dust treatments will be considered separately. In Table 4 the results with solution treatments reveal but few instances in which the rooting percentages were significantly or consistently increased by any of the concentrations of indolebutyric acid employed. In the November to January collections, when the control cuttings rooted to a higher extent than at any other time, there was a reduction, in some cases severe reduction, in the rooting of treated cuttings. In February, 5 and 10 mgms. of indoleacetic acid per liter did not appreciably influence the rooting response as compared with the control, but concentrations of 25 and 50 mgms. per liter were definitely injurious. In the April and June collections there was some improvement of the rooting response, particularly under treatment with 2.5 mgms. of indolebutyric acid per liter, over that of the control lot. The quality of the root systems formed during the propagation period in the April collection was best in the control lot, followed by the lot treated with 10 mgms. of indolebutyric acid per liter. In general, the chemical treatments did not improve the root systems formed in number or length of roots or abundance of fibrous roots.

There was little evidence of a symmetrical physiologic curve of responses such as was found by Grace (1937). The lower concentrations of the chemicals in some cases had slightly beneficial effects or no observable effect while concentrations of 10 to 100 mgms. were increasingly toxic. The higher concentrations of the chemicals caused such severe injury to the bases of the cuttings that the terminal bud and needles began drying out, reddening and defoliating within the first month. In other instances the tops did not defoliate until much later but the stem bases and lowermost needles rotted and became heavily infested with a white filamentous fungus. A number of treated cuttings were found with the basal centimeter of the stem severely injured but with one or several short, thick roots arising just above the injured portion.

Significance is attached to the fact that the practice of standing the bases of freshly made cuttings in tap water for 24 hours frequently was associated with a marked reduction in the rooting of the cuttings so treated. For example, with cuttings taken in November and planted directly in sand the rooting was 60 per cent., but a comparable lot placed in water 24 hours rooted only

35 per cent. Grossenbacher<sup>3</sup> reported orally that wrapping Norway spruce cuttings in moist paper and delaying the planting for two days increased rooting above that of cuttings planted without delay. Priestley and Swingle (1929) observed that no other single factor was so likely to bring about decay at cut surfaces as an excess of water. Healing of cut surfaces of cuttings requires the free access of oxygen. Also in water there is the possibility for various substances to leach out of the wounded tissue. It was

TABLE 5.

Rooting percentages of Norway spruce cuttings from trees 40 years old after 100 days in the propagation bench, showing the effects of chemical dust treatments. Control specimens were planted directly in sand. All the other specimens were dipped in talc or charcoal alone or in these dusts mixed with indolebutyric acid.

Month collected	Control	Talc	I. B. in talc-mgm./gm.			Charcoal	I. B. in char.-mgm./gm.		
			1	2	4		1	2	4
	%	%	%	%	%	%	%	%	%
June .....	12.5	—	2.5	—	—	—	—	—	—
July .....	0	—	0	—	0	—	—	—	—
Aug. ....	22.5	5.0	5.0	15.0	0	12.5	10.0	7.5	12.5
Sept. ....	0	0	0	0	—	—	—	—	—
Oct. ....	10.0	2.5	7.5	—	0	—	—	—	—
Nov. ....	60.0	35.0	55.0	37.5	20.0	30.0	25.0	—	25.0
Dec. ....	80.0	66.0	66.0	—	56.0	78.0	72.0	—	68.0
Jan. ....	56.0	46.6	42.5	—	36.6	60.0	50.0	—	43.3
Feb. ....	44.0	62.5	67.5	—	45.0	—	—	—	—
March ....	50.0	25.0	12.5	—	12.5	—	—	—	—

evident in the present study of Norway spruce cuttings that water and solution treatments had certain detrimental effects which could not be completely ascribed to the chemicals in solution.

The results with dust treatments, Table 5, in the summer and autumn indicated no improvement in rooting by this type of treatment of cuttings from mature trees. However, a series of cuttings taken in July from transplants 5 years old did show a significant increase in rooting when treated with talc containing 1 and 4

<sup>3</sup> Grossenbacher, Karl A.—Experiments on the vegetative propagation of conifers. Address before the New England Section, American Society of Plant Physiologists. Hanover, N. H., May 10, 1940.

milligrams of indolebutyric acid per gram. The control lot rooted 12.5 per cent. and both treated lots rooted 27.5 per cent. These were among the most effective responses recorded for dust treatments of Norway spruce cuttings. The higher concentration, 4 mgm./gm., however, caused discoloration and injury of stem bases with roots arising above the injured areas of the stems.

During December and January when the untreated cuttings rooted best the dust treatments were ineffective in improving the rooting responses. However, in February, talc alone and talc containing the lowest concentration of indolebutyric acid gave significant increases in the percentages of cuttings rooting. There were instances in which the lowest concentration of indolebutyric acid in talc, although not increasing the amount of rooting above that of untreated cuttings, was associated with some increase in the number and length of roots and in the production of more fibrous roots. Infestation with fungi was generally greater in cuttings treated with talc dusts than in the controls, and the highest concentration of indolebutyric acid, 4 mgm./gm., caused basal stem injury in many cases.

The treatments with charcoal alone and as a carrier for indolebutyric acid were somewhat superior to the results obtained with talc in the August, December and January collections, but in November the results with talc treatments surpassed those with charcoal. In but one case, charcoal alone in January, was the rooting percentage higher for a treated lot than a control lot. More irregularity in the quality of the root systems was noted in cuttings treated with charcoal than with talc. Fungi developed more abundantly on cuttings dipped in charcoal than in talc.

When the cuttings of the December collection were dug to record survival and rooting data, a classification of the root systems was made on the basis of quality. These data are recorded in Table 6. Substantial rooting and excellent survival occurred with all but one treatment—indolebutyric acid solution of 100 mgm. per liter. In this lot the concentration of the chemical was high enough to cause severe injury. On the basis of both high percentage of rooting and superior quality root systems the control lot ranked first. On the basis of root quality the cuttings treated with talc were of the same rank as the controls, followed by those treated with talc containing 1 mgm. of indolebutyric acid per gram, and next by those placed in water 24 hours. The cuttings treated



with charcoal rooted to 78 per cent. but more than half of the root systems were considered inferior in quality. The outstanding result is that Norway spruce cuttings collected in December and placed directly in sand without further treatment will produce a high percentage of superior quality root systems. No special chemical treatment proved to be consistently more effective than the regular control procedure.

*Influence of the Propagating Environment upon the Survival and Rooting of Norway Spruce Cuttings.* In the winter period difficulties were encountered in procuring the survival of white

TABLE 6.

Rooting, survival and quality of Norway spruce cuttings collected in December from trees 40 years old.

Treatment	Rooted	Survived	Quality of root systems	
			Superior	Inferior
	%	%	%	%
Control .....	80.0	96.0	88.2	11.8
Charcoal .....	78.0	94.0	47.2	52.8
Water, 24 hrs. ....	77.5	100.	72.4	27.6
Charcoal + I. B. 1 mgm./gm. ....	72.0	100.	52.9	47.1
Solution of I. B., 2.5 mgm./l. ....	70.0	92.5	55.2	44.8
Charcoal + I. B. 4 mgm./gm. ....	68.0	96.0	50.0	50.0
Talc .....	66.0	98.0	88.4	11.6
Talc + I. B. 1 mgm./gm. ....	66.0	98.0	78.5	21.5
Solution of I. B., 0.3 mgm./l. ....	65.0	97.5	52.0	48.0
Solution of I. B., 10 mgm./l. ....	65.0	90.0	56.0	44.0
Talc + I. B. 4 mgm./gm. ....	56.0	92.0	65.3	44.7
Solution of I. B., 100 mgm./l. ....	37.5	62.5	33.4	66.6

pine cuttings. To overcome these, trials of sweat bench and cold room environments were made. At the same time Norway spruce cuttings were tested under these conditions. During the summer an outdoor frame provided with cloth shades was also tested with cuttings of Norway spruce and other species. Data on the survival and rooting of Norway spruce cuttings under the conditions existing in the open greenhouse benches, in a sweat bench, and in an electrically heated sand bench in the cold room are given in Table 7. Figures 2, 3 and 4 of Plate I illustrate typical rooted cuttings propagated in the three environments.

The sweat bench in the main room of the greenhouse was oper-

ated in the usual manner of such closed benches only from mid-December to mid-January; thereafter the top sash was raised or entirely removed. When closed, the sand in the sweat bench ranged between 72 to 84 degrees Fahrenheit, and when the top sash was removed temperatures 2 to 5 degrees above those of the open benches prevailed. During the first month the Norway spruce cuttings made in December were therefore subjected to relatively high temperatures and humidities. The result was a prompt and large callusing of many of the cuttings and the formation of roots on a few during the first 30 days. At the conclusion of the propagation period, 100 days, 48 per cent. of the cuttings were rooted and a number of these had unusually long, well-branched roots.

TABLE 7.

Survival and rooting of Norway spruce cuttings planted in three propagating bench conditions. Cuttings from trees 40 years old and the survival and rooting percentages recorded after 100 days.

Month collected	Open bench		Sweat bench		Cold room	
	Survived	Rooted	Survived	Rooted	Survived	Rooted
	%	%	%	%	%	%
Dec. ....	96.0	80.0	50.0	48.0	100.	0 *
Jan. ....	100.	56.0	82.0	46.0	100.	40.0
Feb. ....	90.0	44.0	100.	76.0	100.	22.0
March ....	97.5	50.0	100.	85.0	100.	62.5

\* In July or after 200 days 97.5 per cent. survived and 50.0 per cent. rooted.

But survival was confined practically to the cuttings that succeeded in rooting early. The remainder were badly rotted at the stem bases although many of the tops were normally green. In the January collection the rooting response of the cuttings in the open sweat bench was less than in the open bench, and the roots were long, indicating early initiation of root formation. Survival was reduced by considerable rotting of the stem bases by fungus infestation. With increased ventilation of this bench in February and March both survival and rooting of the cuttings increased. It was apparent that the closed sweat bench during the initial month of propagation stimulated early callusing and rooting but had the disadvantage of causing increased rotting of the cuttings. The open sweat bench with slightly higher temperature and humidity than the open benches was more favorable for root formation than the open benches in February and March.

In the cold room the day air temperatures ranged from 30° to 72° F., with an average range between 50° to 60° F. The electrical heating unit in the open bench of the cold room maintained temperatures of 53° to 64° F., in the upper layer of the sand during December and January. The arrangement in the cold room gave perfect survival throughout with a minimum of rotting and surface infestation with fungi, but the low range of temperature was not conducive to rooting. None of the cuttings collected in December and placed in the cold room rooted in 100 days; but by July, 50 per cent. of them had rooted, though not as vigorously then as the controls in the open bench in the main room had been rooted in March. Reduction in the number of cuttings that rooted in the cold room was also recorded for material collected in January and February. With the increase in temperature from March onwards the rooting percentages increased but the root systems were smaller than those of cuttings handled in the warm greenhouse.

The winter trials of open bench, sweat bench and cold room conditions indicated that Norway spruce cuttings can be satisfactorily handled in open benches in a warm greenhouse. The sweat bench speeds callusing and rooting, but many of the cuttings rot. The temperatures in the cold room were not sufficiently high to induce prompt rooting.

In May, July and early September Norway spruce cuttings were placed in an outdoor shaded sand bed. Even though the bed was sprinkled several times a day and with a fine mist during the noon periods on the hottest days, many of the larger cuttings defoliated in July. No rooting and practically no callusing occurred with the cuttings in the outdoor frame. In the greenhouse a few cuttings rooted from summer collections. It may be mentioned that better success attended the propagation of summer cuttings of several hardwoods in the outdoor frame.

*Influence of the Presence or Absence of the Terminal Bud upon the Rooting of Norway Spruce Cuttings.* During the winter considerable numbers of twigs were found disbudded, presumably by birds, as many fragments of buds lay on the snow beneath the trees. It was thought of interest to learn if such disbudded twigs would root as successfully as intact twigs, so three tests were made, with the results given in Table 8. In two of the tests there was no apparent difference in the rooting response of normal and

disbudded cuttings. In the May collection, however, the rooting of the disbudded cuttings was higher than that of any other lot of the cuttings taken in the random sample of 40-year old trees. Whether the terminal bud at certain stages of growth exerts a checking influence upon root development as suggested by Van der Lek (1934) in his work with *Populus candicans* would require further experimentation to determine. It is evident that disbudded cuttings can be used in the spring if it is desirable to secure as many cuttings as possible from certain trees.

*The Rooting of Cuttings from Norway Spruce Trees Infested with Spruce Gall Aphids and from Immune Trees.* In the New England states Norway spruce trees are commonly attacked to a greater or lesser extent by the spruce gall aphid (*Adelges abietis*

TABLE 8.

Rooting percentages of intact Norway spruce cuttings and of those lacking a terminal bud.

Month collected	Intact cuttings	Cuttings without terminal bud
	%	%
March .....	52.5	50.0
May .....	20.0	42.8
July .....	0	0

L.) which causes galls to develop at the base of twigs. Wilford (1931) and Friend and Wilford (1933) have given accounts of this pest in Connecticut. In the Norway spruce plantations from which cuttings were secured in the present study at least 15 to 20 per cent. of the trees were infested. In the random collections of cuttings infested trees were avoided as sources of cuttings. An interesting case of apparent immunity is seen in these plantations where heavily infested trees may be surrounded and even touch the branches of trees showing no past or present sign of infestation.

Comparisons were made of the rooting responses given by cuttings from infested and immune trees, Table 9. Only a few of the cuttings from infested trees had a basal gall and in no case were roots formed from such atypical cuttings. The data reveal but one month, June, when the rooting response was higher for cut-

tings from infested trees than from immune trees. Dormant cuttings in December and February rooted in much larger percentages when taken from immune trees than from infested trees.

*Clonal Variation in the Capacity of Norway Spruce Cuttings to Root.* Variations in growth habit, rate of growth, morphological characters and in immunity to spruce gall aphid were obvious in the trees in the several forest plantations from which Norway spruce cuttings were collected. It was also apparent in the propagating bench that marked differences existed between cuttings in the time when bud development started, whether terminal, lateral or both types of buds would develop and in the character of the initial root systems formed. At the end of a propagation period

TABLE 9.

Rooting percentages of Norway spruce cuttings from trees infested with spruce gall aphid and from non-infested trees.

Month collected	Infested	Not infested
	%	%
May .....	16.6	20.0
June .....	20.0	12.5
July .....	0	0
Aug. ....	10.0	22.5
Dec. ....	15.6	80.0
Feb. ....	3.3	44.0

it was observed that sometimes many healthy cuttings with or without development of buds did not root, while others in similar condition or in poorer condition rooted profusely. These observations suggested that the rooting or non-rooting may be in part an inherited characteristic present in the twigs of some trees to a much greater extent than in others. A review of the literature revealed only a few studies in which the rooting characteristics of individual trees had been investigated. Zimmerman and Hitchcock (1929) found a variation in the rooting of one group of four holly trees in Massachusetts of 39.5 to 81.5 per cent. and of another group in New Jersey 64.0 to 79.0 per cent. These writers suggested that the differences might be due either to inherent factors or to failure to select comparable cuttings. Snow (1939) designed an experiment to test clonal variation in the

rooting response of cuttings from red maple trees. With 24 clones the rooting responses ranged from 17.5 to 97.5 per cent. and the conclusion was reached that the different rooting abilities of the clones of this species were conditioned either on an inherent difference in natural rooting ability or on an inherent difference in response to specific auxin applications.

Testing large numbers of clones with samples of adequate size is a space-demanding procedure in the greenhouse, so it was only possible to make tests of the responses of approximately 40 trees. In Tables 10 and 11 the data of rooting responses of cuttings from

TABLE 10.

Rooting percentages of cuttings from clones of Norway spruce trees 26 years old, collected during three months.

Clone No	Collected in May	Clone No.	Collected in Dec.	Clone No.	Collected in March
	%		%		%
11	76.0	625	3.3	842	65.0
12	68.0	626	6.6	843	60.0
13	93.0	627	43.3	844	0
14	75.0	628	6.6	845	35.0
15	95.0	629	10.0	846	75.0
16	100.	630	13.3	847	80.0
17	92.5	631	23.3	848	25.0
		632	3.3	849	35.0
		633	36.6	850	100.
		634	53.3		
Mean	85.6		19.9		52.8

individual trees in a 26-year old plantation and from those in a 40-year old plantation are summarized. The cuttings were all made of twigs one year old and were planted directly in the sand without chemical treatment. From 20 to 100 cuttings were used per sample.

Figures 1 to 4, Plate II show some striking variations in the character of the root systems produced by cuttings of four clones of the collection in May. Reference has been made to the high average rooting, 85.6 per cent., of the cuttings collected in May from the 26-year old trees in the discussion of the influence of the age of the parent tree on the rooting response. The average

rooting percentage of the cuttings of these trees collected in December was only 19.9 per cent., a result at variance with the seasonal data secured with cuttings collected in December. The data of Table 10 show that the range of the rooting responses of the clones of cuttings collected in May was less than those obtained from collections made in December and March. In the March

TABLE 11.

Rooting percentages of cuttings from clones of Norway spruce trees 40 years old, grouped on a basis of vigor of growth. The cuttings were collected during three months.

Clone No.	Condition of trees	Collected in:		
		Sept.	Nov.	Dec.
		%	%	%
247	Vigorous .....	0	62.5	70.0
254	Vigorous .....	0	35.0	63.3
255	Vigorous .....	0	3.3	13.3
	Mean	0	33.6	48.8
249	Moderately vigorous .....	0	22.5	40.0
251	Moderately vigorous .....	0	3.3	46.6
252	Moderately vigorous .....	0	7.5	3.3
253	Moderately vigorous .....	0	—	66.6
256	Moderately vigorous .....	0	12.5	53.3
	Mean	0	11.4	41.9
248	Non-vigorous .....	0	20.0	53.3
250	Non-vigorous .....	0	12.5	16.6
257	Non-vigorous .....	0	27.5	43.3
258	Non-vigorous .....	0	—	90.0
	Mean	0	20.0	50.8

collection the rooting percentages ranged from 0 to 100 per cent. The chance inclusion of a few more low or high rooting clones in small samples of clones would greatly influence the average or mean for a given collection.

The clones in the 40-year old plantation were selected on a basis of the vigor of the tree as judged by height and current twig growth. It was obvious that a seasonal factor was controlling to a marked extent the rooting responses recorded with

cuttings collected in September, October and December. The greatest range in the rooting responses of individual clones was in the December collection from inferior trees, the range being 16.6 to 90 per cent. Adequate data are not available to form a judgment on the influence the vigor of growth of the parent tree may exert upon the rooting capacity of stem cuttings. The existence of large clonal variations in respect to internal factors governing the rooting responses of Norway spruce cuttings is clearly shown by the results obtained.

*Discussion of the Results with Norway Spruce Cuttings.* There was abundant evidence that stem cuttings of both young and old Norway spruce trees possess a natural capacity to regenerate roots. This capacity is more highly developed in cuttings from seedlings than in cuttings from older trees, and with the younger material rooting is less subject to a seasonal course of a distinct maximum in mid-winter and a minimum in summer. The graphs representing the quantitative aspects of root regeneration from October to February with cuttings from 40-year old trees have the appearance of symmetrical curves delineating "grand periods" of growth. With progress of winter dormancy a developmental stage is reached in Norway spruce twigs which appears to be particularly favorable to the initiation and continued formation of roots when cuttings are taken and placed under conditions satisfactory for the resumption of growth. In the vicinity of New Haven, Connecticut, the optimum time for collecting Norway spruce cuttings for propagation is approximately mid-December. It is possible that trees growing north of New Haven, for example in Maine or Canada, and subjected to low temperatures earlier in the fall will yield cuttings that will root satisfactorily some weeks earlier than those studied. Variations in the dates of the first killing frost or the onset of cold weather undoubtedly modify the optimum time for taking cuttings.

The explanation of the seasonal character of the abundant rooting of Norway spruce cuttings appears to be associated with maturity of the stem and bud tissues and the attainment of a certain state of dormancy. It is well known that hardy perennials require exposure to chilling temperatures for varying lengths of time to make them dormant and resistant to freezing temperatures (Coville, 1920; Strausbaugh, 1921). With many species in the temperate zone, the normal opening of buds and the resumption



of growth in the spring is dependent upon an exposure of the tops to chilling temperatures for varying periods. With white elm trees, Jones (1938), has found both the temperature and the photo-period characteristics of the season of significance to the onset and progress of the dormancy of the buds. It is also known that the dormant buds of deciduous trees and shrubs can be caused to resume active growth by various chemical treatments, Denny and Stanton (1928). Guthrie (1938 and 1939) found it possible to induce a state resembling natural dormancy in potato tubers by a first chemical treatment, and then induce the resumption of growth with a second treatment with another chemical. The chemical changes occurring within the tissues of twigs have been studied by Hooker (1920), Abbot (1923), and others. In addition to these valuable contributions upon dormancy in woody plants there is now some information available upon the presence and probable control exerted by plant growth substance or hormone.

Studies of plant growth substance concentration in buds and stems of trees by Zimmermann (1936) and Avery, Burkholder and Creighton (1937) have shown that dormant winter buds of various species give no indication of the presence of active growth substance. But as terminal buds swell with the commencement of growth in the spring the content of growth substance rises rapidly with a maximum content occurring just before the period of most rapid shoot growth. Bennett and Skoog (1938) found that exposure of dormant fruit tree stems to cold was essential for the termination of the rest period and that renewal of growth was accompanied by the accumulation of auxin. A similar relationship may apply to the increasing tendency of Norway spruce cuttings to root as the shoots are subjected to the low temperatures and shorter days of the late fall and early winter. However, certain observations of the behavior of the buds of Norway spruce have failed to indicate a close dependence of rooting on the state of growth of terminal buds or upon their presence. The later in the winter Norway spruce cuttings are gathered, the more promptly the buds open and begin to grow. Thus, in January and February, activity in the buds is much earlier in appearing and more general than with cuttings gathered in November or December. Yet, the rooting response was greater in December collected cuttings than in those taken in January or February. Further, the results obtained in three experiments with disbudded cuttings indicate

that the presence of terminal buds during the propagation period may not be essential to root formation. The removal of the terminal buds from cuttings collected in May was associated with a significant increase in rooting compared with cuttings having intact buds. However, there are at least two possible explanations for this result. First, before the terminal buds were removed they may have exerted a development-controlling influence. Second, lateral buds and leaves were intact and could exert an influence upon root regeneration in the absence of a terminal bud. Jacobs (1939) described the presence of male cone primordia on cuttings of *Pinus radiata* as completely inhibiting root formation. The details of growth substance content, production and influence of the buds, leaves and stems of Norway spruce cuttings require intensive study before this phase of root formation can be understood. It is also essential that anatomical studies be carried on to follow the initiation and development of the root primordia.

No consistent evidence was found that treatments with indolebutyric or indoleacetic acids improved the rooting of Norway spruce cuttings. This was in accord with previous findings by Deuber and Farrar (1940) and Grace and Thistle (1940). Grace (1940) did find that one dust treatment with indoleacetic acid increased the rooting of cuttings of Norway spruce collected in November by approximately 10 per cent. Thimann and Delisle (1939) reported increased rooting of cuttings of Norway spruce from seedlings 3 years old, treated with indoleacetic acid in solution, but no response with cuttings from trees 60 years old. The failure of Norway spruce cuttings to respond to the various chemicals in series of concentrations in the present study is not understood. Pearce (1939) in an extensive review of the practical applications of synthetic growth substances points out that treatments with these substances have by no means solved all plant propagation problems. Many species known to be difficult to root present certain unknown obstacles to root regeneration which have not been overcome by treatment with synthetic growth substances. In general, these substances have proved most effective with species easy to root or only moderately difficult. With such species standard chemical treatments are frequently effective in shortening the time for the appearance of roots, causing a higher percentage of cuttings to root and in improving the quality of the root systems by inducing more abundant production of lateral and fibrous roots.

There is always the possibility of finding especially effective chemicals, concentrations or methods of application for the species difficult to root.

The demonstration of marked clonal variation in the rooting capacity of cuttings of Norway spruce is considered a pertinent fact to the problem of regeneration. So far, no consistent outward sign of this variation has been detected in the parent stock. It may, however, be useful in the approach to detailed studies of differences in structure, growth or in auxin production. The anatomical study of Siegler and Bowman (1939) of root and shoot production of pieces of apple roots indicated that variations in the manner in which the vascular connections are established between the shoot primordium and the parent tissue probably explain variations in the vegetative response of shoots growing from individual root cuttings. Here it was found that roots must be developed either in advance or concurrently with shoots.

## EASTERN WHITE PINE

The propagation of pines has been carried on almost entirely with seeds. A few of the ornamental varieties have been grafted to multiply the stock. Riker and Kouba (1940) reported successful vincer grafting with scions of young white pine trees that survived in the midst of areas heavily infested with *Cronartium ribicola*. Most of the standard textbooks and encyclopedias of horticulture contain slight or no reference to cuttage practice with species of *Pinus*. Taylor and Knight (1927) mention the resinous nature of cuttings of *Pinus*, *Abies* and *Picea* and recommend a hot water treatment to bring about rapid exudation of the resin. In the list of conifers that were found to respond to solution and powder treatments with indolebutyric acid at the Boyce Thompson Institute, Kirkpatrick (1940) includes *Pinus bungeana* and *Pinus mugho slavini*. Unquestionably propagators in commercial nurseries and botanical gardens have tried to root cuttings of various pines in small lots from time to time. Mr. John H. Murray, Head Gardener, Marsh Botanical Garden, has related that he has secured the rooting of approximately 5 per cent. of the cuttings taken from white pine trees 50 years old. The rooting of cuttings of *Pinus sylvestris* was reported by Kurdiani (1908) and of *Pinus austriaca* by Balfour (1912-1913).

One of the most successful developments in the vegetative propagation of a pine had its inception in New Zealand where nurserymen found that a sport of *Pinus radiata* could be reproduced by cuttage practices. Field (1934) pulled off branches of the top whorls of seedling Insignis or Monterey pines and placed them in a sandy nursery soil. He estimated that not less than 95 per cent. rooted. A thorough investigation of forest nursery practices for handling cuttings of Monterey pine was made by Jacobs (1939) in Australia. In good seasons and with favorable sites it was possible to secure the rooting of over 90 per cent. of the cuttings collected from trees up to six years old. With small samples of slash pine, *Pinus caribaea*, in Florida, Plank (1939) obtained an increased rooting of cuttings and better quality root systems when an initial treatment with indolebutyric acid solution was given the cuttings.

With cuttings from one year old seedlings of white pine Gardner (1929) obtained excellent rooting, but with cuttings from stock of older age classes the rooting rapidly decreased. Mirov (1938) reported the possibility of rooting cuttings of eastern white pine trees 10 years old but gave few details of methods or data. A comprehensive study of the rooting of white pine and other difficult species by Thimann and Delisle (1939) demonstrated the significance of the age of the parent stock in successful root formation. Cuttings from seedlings one and three years old rooted satisfactorily and responded very well to treatments with indoleacetic acid. But cuttings from trees 10 and 65 years old did not root either with or without chemical treatment. Mr. A. G. Snow, Jr., of the Northeastern Forest Experiment Station, has related that in present studies of white pine propagation a maximum rooting of 15 per cent. was secured from cuttings taken from trees 40 years old.

From this brief review of the available information upon the rooting of pines it is evident that much exploratory work is required to understand the characteristics of the cuttings and the trees from which they are secured. To be most effective toward forest improvement cuttage practice should not be limited to the use of young seedling stock, as many desirable features in a tree may become evident only after it has reached an age of ten years or more. The major collections of white pine cuttings in the present study were made from trees in the intermediate and older age classes.

*Experimental.* In May, 1939, a program was started to study the natural rooting capacity of eastern white pine cuttings and the influence of various chemical and physical treatments on these cuttings. From October, 1939, to May, 1940, the author had the greatly appreciated assistance of Mr. Jesse G. Ralston in this program. Ralston (1940) made a preliminary report on some of the data secured to May 1, 1940. Now final survival and rooting data are available for cuttings maintained in the propagation benches for periods of three to seven months.

The general program consisted in a seasonal test, month by month, of the capacity of cuttings of white pine trees 20 to 40 years old to root. In addition, cuttings from seedlings and transplants of several age classes were tested. With the progress of the program through the summer, autumn and winter, difficulties

with survival indicated the need for close attention to features concerned with the preparation and subsequent care of the cuttings.

TABLE 12.

Rooting percentages of untreated white pine cuttings from trees of various age classes. Rooting recorded after 90 to 210 days.

Age and month collected	Rooted	Age and month collected	Rooted
<i>2 years</i>		<i>18 years</i>	
June .....	21.0	March .....	2.8
Sept. ....	0	<i>20 years</i>	
Oct. ....	22.5	Feb. ....	0
Nov. ....	32.5	March .....	0
Dec. ....	20.0	<i>25 years</i>	
Jan. ....	30.0	Sept. ....	0
Feb. ....	93.3	Nov. ....	0
March .....	32.5	March .....	4.0
<i>3 years</i>		<i>30 years</i>	
Jan. ....	70.0	June .....	0
<i>4 years</i>		July .....	0
Feb. ....	69.0	Aug. ....	0
<i>5 years</i>		Oct. ....	0
June .....	0	Dec. ....	14.0
Feb. ....	26.4	Jan. ....	6.0
<i>7 years</i>		<i>40 years</i>	
Jan. ....	26.6	May .....	0
<i>15 years</i>		Sept. ....	0
Oct. ....	0	Nov. ....	0
Nov. ....	2.0	Dec. ....	4.3
Dec. ....	0	<i>60 years</i>	
Jan. ....	7.5	May .....	0
Feb. ....	0	Nov. ....	0
March .....	4.5	Jan. ....	6.6
		Feb. ....	30.0
		March .....	20.0

This necessitated making many special tests, in addition to the routine series of chemical treatments, in order to determine the most satisfactory procedures.

*Survival and Rooting of White Pine Cuttings Taken at Different Seasons.* In collections of material from trees of various age classes in May and June the new shoot growth was still too immature to use for cuttings. By July, cuttings were made of both the growth of the preceding year (1938) plus the current growth (1939) as well as of the current growth alone. A similar program was followed in August, but from September onwards the major collections consisted of the current growth alone. With but a single exception, the untreated cuttings survived very poorly and did not root. Data on all control series are listed in Table 12. In the summer period, within less than 90 days, white pine cuttings showed drying of the needles, fading of leaf pigments, wrinkling of the bark and in many cases severe rotting of the stem base and basal needles. Very limited callusing occurred. Series planted in an outdoor shaded frame remained in better condition than those in the shaded greenhouse benches but none rooted. The only cuttings from 2-year old seedlings taken during this period were made in June and rooting of 21 per cent. resulted. In 90 days the roots of the seedling cuttings were small (1 to 3 cm.) and without lateral branches. Cuttings from 5-year old stock in June rotted early and did not root. The survival of cuttings taken in August improved over those taken in May to July but only two cuttings (5 per cent.) rooted in a series treated with indolebutyric acid in charcoal, 1 mgm./gm. The failure of white pine cuttings to survive in appreciable numbers when collected in the late spring and summer months is a serious obstacle to successful propagation in these seasons. Norway spruce cuttings survived more satisfactorily than white pine cuttings during the summer.

The September collection, made largely from trees 40 years old, showed good survival of the cuttings during the first two months, but in the third month many of the needles were drying out. Many lost their green color and a considerable number died. Callusing of the stem bases was more advanced than it was with the summer cuttings at a similar stage in the propagation benches. However, no rooting occurred in any of the series of cuttings collected in September.

From October through the mid-winter months there was marked improvement in the survival of cuttings of all age classes, with more prompt callusing and rooting, with the cuttings from the younger age classes. Survival and rooting data for the January

and February collections are summarized in Table 13. During these months as well as in December and March excellent survival was recorded for most series in 90 days, continuing in some cases for five to seven months. While rooting did not exceed 14 per cent. in one December lot of untreated cuttings from trees 30 years old, and 30 per cent. in cuttings from a tree 60 years old taken in February, recognition of the fact that adequate survival can be maintained in cuttings taken in mid-winter is an essential preliminary step to the successful rooting of this species. Experience has shown that white pine cuttings require considerable time to form roots, a minimum period of three months appearing necessary for

TABLE 13.

Survival and rooting percentages of untreated white pine cuttings taken from trees of various age classes in January and February.

Age years	Month collected	In 90 days		In 120 days		In 150 days		In 180 days	
		Surv.	Root.	Surv.	Root.	Surv.	Root.	Surv.	Root.
		%	%	%	%	%	%	%	%
2	Jan. ....	33.3	16.6	30.0	30.0	—	—	—	—
2	Feb. .	—	—	100.	93.3	—	—	—	—
3	Jan. ..	—	—	100.	16.6	—	—	80.0	70.0
4	Feb. .	88.1	57.1	—	—	85.4	69.0	—	—
5	Feb. ...	85.3	14.7	—	—	73.5	26.4	—	—
7	Jan. ....	100.	—	66.6	23.3	—	—	33.2	26.6
15	Jan. . .	—	—	—	—	85.0	5.0	67.5	7.5
15	Feb. ....	—	—	95.0	0	67.5	0	—	—
20	Feb. ...	—	—	80.0	0	77.7	0	—	—
30	Jan. ....	98.0	0	—	—	78.0	6.0	26.0	6.0
60	Feb. ....	95.0	—	95.0	20.0	70.0	30.0	—	—

any appreciable initiation of this process; and root regeneration frequently continues for at least three additional months. The mid-winter to March period gave more promise of success in rooting white pine than any other season. The rooting of cuttings from seedlings was not influenced as much by seasonal conditions as were cuttings from older stock. However, the best rooting of seedling cuttings, 93.3 per cent., was obtained with material collected in February.

*Influence upon Rooting of the Age of the Parent Trees from which White Pine Cuttings were Collected.* In the eight months during which cuttings from 2-year old seedlings were tested, see



Table 12, only those collected in September failed to root. Maximum rooting, 93.3 per cent., occurred in February collected cuttings. Other than this February high result no particular seasonal trend was found in the rooting responses. Survival of the seedling cuttings was sometimes limited to those cuttings which produced roots early during propagation.

With a single exception, cuttings from nursery or transplant stock 3 to 7 years old were taken in January and February, a period when survival was best. In these age classes rooting responses of 26.4 to 70 per cent. occurred. The most significant differences between the rooting capacity of cuttings from the trees 3 to 7 years old appeared to be those between the 4- and 5-year old age classes collected in February. These cuttings were secured at the same time from neighboring transplant beds, yet the cuttings from 4-year old trees rooted 69 per cent. and those from the 5-year old trees 26.4 per cent. This suggests that a marked transition occurred in the rooting capacity of cuttings from parent stock between the ages of four and five years. The rooting of cuttings from 3- and 4-year old stock was of the same order, 70 and 69 per cent., respectively. The rooting of cuttings from 5- and 7-year old stock was 26.4 and 26.6 per cent. respectively. The last rooting percentages are intermediate between those recorded from younger and older age classes.

Very little rooting occurred with random samples of cuttings of the 15- and 18-year old age classes. In March, a test was made of 20 cuttings each of 14 trees of the 15-year old age class. In 105 days the cuttings from six trees had not rooted; those from four trees rooted 5 per cent.; those from three trees rooted 10 per cent.; and those from 1 tree rooted 20 per cent. The average rooting of the 280 cuttings was 4.5 per cent. These results probably indicate the occurrence of considerable clonal variation in the rooting capacity, as was found with Norway spruce cuttings.

Cuttings from trees 20 to 40 years old gave but meager rooting. The December and January collections from trees 30 years old survived well and formed calluses early, but the final rooting after 180 days was but 14 and 6 per cent., respectively.

Special interest is attached to the results obtained from cuttings from a single tree estimated to be 60 years old. In May and November no rooting occurred, in January 6.6 per cent. rooted. In February, two collections were made from this tree with rooting

responses of 5 and 30 per cent. of the cuttings. Rooting was 20 per cent. in a March collection. This capacity of the cuttings of a mature white pine tree to produce roots appears to be explainable on the same basis as the tests of clones reported for 15-year old trees in which the cuttings of 8 trees rooted and those of 6 others

TABLE 14.

Rooting percentages of white pine cuttings in monthly collections from trees 20 to 40 years old untreated and treated with indolebutyric acid in solution and in talc or charcoal and with several additional chemicals.\* Rooting recorded after 120 to 210 days.

Treatment	Oct.	Nov.	Collected in:			
	%	%	Dec.	Jan.	Feb.	March
Untreated .....	0	0	14.0	6.0	0	0
Water—24 hrs. ....	0	0	5.5	6.6	—	—
I. B. soln. 0.3 mgm./l. ....	0	0	0	3.3	—	—
I. B. soln. 2.5 mgm./l. ....	2.5	0	5.0	13.3	—	—
I. B. soln. 10.0 mgm./l. ....	0	0	10.0	13.3	—	—
I. B. soln. 25.0 mgm./l. ....	—	—	—	—	—	0
I. B. soln. 50.0 mgm./l. ....	—	—	—	—	—	0
I. B. soln. 100.0 mgm./l. ...	5.0	0	10.0	26.6	—	—
Talc .....	0	2.5	10.0	6.0	7.5	2.5
I. B. in talc 0.1 mgm./gm. ..	7.5	—	—	—	—	—
I. B. in talc 1.0 mgm./gm. ..	0	0	10.0	10.0	22.5	0
I. B. in talc 4.0 mgm./gm. ..	2.5	2.5	12.5	3.3	2.5	0
Charcoal .....	—	0	5.0	10.0	—	—
I. B. in char. 1 mgm./gm. ..	—	0	7.5	3.3	—	—
I. B. in char. 4 mgm./gm. ..	—	0	10.0	3.3	—	—
I. A. soln. 6.2 mgm./l. ....	—	—	—	—	2.5	—
I. A. soln. 12.5 mgm./l. ....	—	—	—	—	2.5	—
I. A. in talc 4 mgm./gm. ...	—	0	10.0	0	5.0	—
Nap. in talc 4 mgm./gm. ...	—	0	12.0	0	7.5	—
Nap. A. in talc 4 mgm./gm.	—	0	0	0	—	—
Hormodin No. 3 .....	—	—	0	0	—	—

\* Abbreviations: I. B. for indolebutyric acid, I. A. for indoleacetic acid, Nap. for  $\alpha$ -naphthaleneacetic acid, Nap. A. for  $\alpha$ -naphthyleneacetamide.

did not. It is possible that the scattered and low rooting of random collections of cuttings from trees 20 to 40 years old may have been due to the inclusion in the cuttings of a very few clones that retained the capacity to root. This possibility requires further testing, and the underlying causes for root regeneration in the cuttings from some clones and not from others requires study.

*Influence of Chemical Treatments on the Rooting of White Pine Cuttings.* Through the year a large number of tests were made of the effectiveness of four root-including chemicals: indoleacetic, indolebutyric,  $\alpha$ -naphthaleneacetic acids and  $\alpha$ -naphthylacetamide. Some of these chemicals were used in aqueous solutions and others were mixed with talc or charcoal. A summary of the survival and rooting data of cuttings from trees 20 to 40 years old from October to March is summarized in Table 14, and for seedlings, 15-year old and 60-year old trees in Table 15. The rooting percentages of the cuttings from 20- to 40-year old stock were very low in the control as well as in the chemically treated lots. There were relatively few instances in which the chemical treatments materially increased the rooting response. The most consistent positive effects of chemical treatments were observed in the January collection, especially with indolebutyric acid in solution at a concentration of 100 mgm./l., with which treatment 26.6 per cent. of the cuttings rooted, as contrasted with only 6 per cent. of the controls. In this instance the solution treatment caused but slight basal injury to the cuttings. In some collections the solution treatments, especially with concentrations of indolebutyric or indoleacetic acids of 50 or 100 mgm./l., proved to be injurious, and when rooting occurred the roots emerged from above the basal zone. Treatments with talc or charcoal alone were associated with several slight increases in rooting above those of control groups. While the dust method for applying the chemicals was convenient and produced less injury than the more concentrated solution treatments, rooting of the cuttings was in no instance materially increased by the various dust treatments.

Not all seedling cuttings responded with increased rooting when given a chemical treatment as is seen in the data for 3-year old stock in Table 15. Some significant qualitative results were noted with the Hormodin treatments of the cuttings of the 4-year age class and are illustrated by Figures 1 and 2 of Plate V. Although the more concentrated preparation, Hormodin No. 3, caused a higher percentage of cuttings to root than Hormodin No. 1, the quality of the roots as indicated by number, length and particularly branching was superior for those treated with Hormodin No. 1.

The mortality of cuttings from 5-year old transplants increased in the two series treated with Hormodin dusts, and only Hormodin No. 3 caused an increase in rooting. The root systems produced

by the cuttings of the 5-year old age class were smaller than those of the 4-year old age class and of an inferior quality. Survival and rooting percentages were decreased when cuttings from 7-year

TABLE 15.

Survival and rooting percentages of white pine cuttings from trees 2, 4, 5, 7, 15 and 60 years old untreated and treated with various chemicals. Rooting recorded after 120 to 180 days.

Age Years	Month collected	Treatment	Survived %	Rooted %
2	Jan.	Untreated .....	16.6	13.3
2	Jan.	I. A. in talc 4 mgm./gm. ....	23.3	10.0
4	Feb.	Untreated .....	85.4	69.0
4	Feb.	Hormodin No. 1 .....	85.4	73.8
4	Feb.	Hormodin No. 3 .....	95.2	78.5
5	Feb.	Untreated .....	73.5	26.4
5	Feb.	Hormodin No. 1 .....	58.8	26.4
5	Feb.	Hormodin No. 3 .....	52.8	38.2
7	Jan.	Untreated .....	33.2	26.6
7	Jan.	I. A. in talc 4 mgm./gm. ....	13.3	3.3
15	Feb.	Untreated .....	67.5	0
15	Feb.	Hormodin No. 1 .....	80.0	0
15	Feb.	Hormodin No. 3 .....	72.5	10.0
15	Feb.	Vitamone .....	95.0	2.5
60	Nov.	Untreated .....	76.0	8.0
60	Nov.	I. B. in talc 1 mgm./gm. ....	60.0	12.0
60	Nov.	I. B. in talc 2 mgm./gm. ....	20.0	4.0
60	Nov.	I. B. in soln. 10 mgm./l. ....	4.0	0
60	Nov.	I. B. in soln. 100 mgm./l. ....	0	0
60	March	Untreated .....	50.0	0
60	March	I. B. in talc 4 mgm./gm. ....	75.0	15.0
60	March	I. A. in talc 4 mgm./gm. ....	85.0	5.0

old trees were treated with indoleacetic acid in talc, 4 mgm./gm. An injurious action of the chemical was evident. However, with cuttings of the 15-year old stock survival was increased by dust treatments. Both Hormodin No. 3 and Vitamone were associated

with slight rooting in this series. In November, two solution treatments of cuttings from a 60-year old tree markedly reduced survival while a slight increase in rooting occurred with one dust treatment. In March, a treatment with talc containing indole-butyric acid, 1 mgm./gm., resulted in 15 per cent. of the cuttings rooting. In another control series from this tree in March, 20 per cent. of the cuttings rooted.

The results obtained with various chemical treatments of cuttings taken at different seasons, and from trees of various age classes, make generalizations on the effectiveness of these treatments difficult. Strikingly significant increases in rooting ascrib-

TABLE 16.

Survival and rooting percentages of three sizes of white pine cuttings from trees 15 years old, taken in November and propagated in the open bench or pre-callused in the sweat bench for 20 days.

Bench treatment and Size of cuttings	50 days	Survival after:			150 days	Rooted
		90 days	120 days			
Open bench	%	%	%	%	%	
Small, 3 to 6 in. ....	94	66	36	20	2.0	
Medium, 6 to 8 in. ...	80	55	45	15	0	
Large, 8 to 12 in. ....	44	0	—	—	0	
Pre-callused 20 days						
Small, 3 to 6 in. ...	96	66	46	30	3.3	
Medium, 6 to 8 in. ....	100	50	30	10	0	
Large, 8 to 12 in. ....	100	11	11	5	0	

able to chemical treatment were not found. There were instances of slight to moderate increases in rooting, particularly in the younger age classes, but even such responses were relatively few in the age classes of 20 to 40 years in which positive influences were most desired. There was some evidence that chemical treatment improved the quality of the root systems in a few instances. In other lots definite signs of injury resulted from some of these chemical treatments.

*The Size of White Pine Cuttings.* Early in this investigation it was observed that large cuttings, 8 to 12 inches long, showed wilting and flagging of needles within a short time in the propagating benches. This condition is illustrated in Figures 1 and 2,

Plate III. Small to medium sized cuttings survived to a greater extent and were more prone to root than the larger cuttings even when the latter survived for a reasonable length of time. Several experiments were designed to test this size of cutting feature and the data of one of these are given in Table 16. The large cuttings were terminal shoots and the medium and small, lateral twigs. All cuttings were secured from branches in the lower third of the crown.

In the experiment from which the data of Table 16 were taken a comparison of survival in the open bench was compared with that of cuttings pre-callused for 20 days in a sweat bench and then transferred to the open bench. The superior survival of the small and medium size cuttings in the open bench was apparent in the first month, and in seven weeks 54 per cent. of the large cuttings died. Under sweat bench conditions in which transpiration was reduced to a minimum the large cuttings survived satisfactorily during the first 50 days but apparently could not cope with the drier atmosphere of the greenhouse when placed in the open benches. In the sweat bench the larger cuttings formed larger and more complete calluses than the smaller cuttings. A greater reserve of foods may be one explanation for this difference in callusing. However, the questionable advantage in callusing did not lead to subsequent survival in the open bench. Thimann and Delisle (1939) found that both survival and rooting was definitely better with lateral branches of white pine than with terminal shoots. The extent to which auxin content and morphogenetic or physiological factors enter into the explanation of the observed facts is not known. It was apparent that large cuttings dry out more readily than small or medium, and practically all the rooting of white pine cuttings in this investigation occurred with the small to medium size classes. Experience in this investigation favors the use of white pine cuttings 2 to 4 inches long.

*Influence of Trimming Off the Lower Needles of White Pine Cuttings.* Plant propagators frequently trim off a portion of the foliage of softwood cuttings to reduce the transpirational losses and accommodate more cuttings in a given space. White pine cuttings of medium size, 4 to 6 inches long, have an average of 36 leaf fascicles and a leaf area of approximately 200 square centimeters. About two-thirds of the leaf surface contains stomata through which the major loss of water-vapor occurs.

In the spring and summer periods of this study, when the white pine cuttings appeared to suffer chiefly from inadequate absorption of water accompanied by high evaporation, the needles were trimmed from the basal third of large numbers of the cuttings. It soon became apparent that the trimming was wholly injurious. Several specific tests were conducted to observe the rapidity and quantitative aspects of trimming. In Table 17 the data of one of these tests are given. Within a month differences in ability to survive were usually detectable between control and trimmed cuttings, and in three months the detrimental influence of trimming was marked. It was also noted that chemical treatment of the

TABLE 17.

Survival and rooting percentages of cuttings from white pine trees 15 years old collected in November and showing the influence of trimming off the lower needles.

Treatment	50 days	Survival after:		150 days	Rooted
		90 days	120 days		
Open bench	%	%	%	%	%
Intact .....	81	50	31	15	0
Trimmed ....	71	13	10	3	0
Pre-callused 20 days					
Intact .....	98	47	32	18	1.5
Trimmed ....	79	19	18	4	0

cuttings increased the deleterious effects of trimming. Intact cuttings having fascicles of needles on the stem base and buried in the sand would frequently show discoloration and rotting of the lower needles; but the cuttings maintained the upper needles in a healthy state and the stem base was apparently protected by the callus. The stubs of excised needles rotted rapidly, together with the stem bases and the upper needles became chlorotic. Jacobs (1939) reported that stripping the lower needles of *Pinus radiata* cuttings was harmful in several ways. This practice definitely reduced the strike of roots, and injury from frost-heaving was greater with trimmed than with untrimmed cuttings.

Various hypotheses have been offered to explain the significance of buds and foliage to the rooting of cuttings. Van der Lek's (1934) studies on the influence of buds on rooting has been men-

tioned in connection with disbudded Norway spruce cuttings. Went (1929) observed that buds and leaves of *Acalypha* cuttings promoted the formation of roots and he considered it advisable to remove as few leaves as possible. Similarly, Rappaport (1939) found that the presence of as many leaves as possible on cuttings of *Skimmia foremanii* favored rooting. Two explanations were suggested for the influence of the foliage: (1) the formation of a hypothetical root-forming substance in the leaves, and (2) the possibility that the greater leaf surface permitted more growth substance to be sucked in with chemical treatments. Zimmerman and Hitchcock (1933) found that cuttings of evergreen hollies did not root when all the leaves were removed before planting. Whatever the ultimate explanation for the influence of leaves on rooting, the experience with white pine cuttings indicated con-

TABLE 18.

Survival and rooting percentages of cuttings from white pine trees 15 years old, collected in November from intact and ringed branches.

Treatment	Survival after:			Rooted
	50 days	90 days	150 days	
Open bench	%	%	%	%
Intact branches .....	94	66	20	2.0
Ringed branches .....	100	52	24	0
Pre-callused 20 days				
Intact branches .....	96	66	30	3.3
Ringed branches .....	96	84	24	8.0

clusively that survival and rooting was distinctly favored by allowing the cuttings to retain their normal complement of needles.

*The Influence of Ringing the Branches of White Pine Trees upon the Rooting of Cuttings.* When a cut encircling a branch penetrates to the cambium, the translocation of foods, chiefly carbohydrates from foliage beyond the ring, is interfered with in the severed conducting elements, and foods accumulate beyond the ring. A number of studies have been made of the biochemical relationships and the regeneration of roots in cuttings of tomato, coleus, rose and other plants by Reid (1924), Starring (1924), Schrader (1925), Smith (1928), Carlson (1929) and others. Priestley (1926) expressed the opinion that "root initials" arise



as a result of the accumulation of carbohydrates above the ring and therefore explain the more ready rooting of ringed than intact shoots when used as cuttings. Jacobs (1939) found that a preliminary partial breaking of the shoots of *Pinus radiata* while still on the trees produced a significant improvement in root strike over the usual cutting procedure.

In October, 1939, the branches of two groups of 15-year old white pine trees were subjected to ringing by completely encircling the bark with a knife near the bases of the twigs. In 30 days the twigs were removed at the point of the ringing and planted together with controls. The data of one of these experiments, Table 18, do not reveal significant differences in survival or rooting between the ringed and control cuttings. Ringing did favor more rapid and abundant callusing during the initial treatment in the sweat bench. Additional study of this technique is required so that the period between the time of ringing and taking the cuttings can be extended. The pliable nature of the wood of white pine twigs at the close of the growing season makes the more laborious ringing process advisable instead of a partial quick breaking of the stems.

*Removal of Resin from the Bases of White Pine Cuttings.* At the bases of white pine cuttings a flow of resin occurs when they are first cut and continues for several days. When placed in sand, a hard crust of sand and resin formed about the bases of the cuttings, particularly during the summer and fall when the greenhouse benches were not heated from below. That this sand-resin crust may interfere with root formation in coniferous cuttings has been suggested by various workers. Taylor and Knight (1927) recommended placing the bases of coniferous cuttings in hot water (130° to 150° F.) for a short time to cause a free flow of resin. Mirov (1938) recommended a hot water treatment for white pine cuttings. However, Thimann and Delisle (1939) found no beneficial effect with hot water treatments.

Tests were conducted in the autumn to determine the influence of hot water and cold water treatments preliminary to planting as well as the removal of excess resin from the cutting bases with alcohol. Standing the bases of cuttings in water at 100° F. for a day before planting resulted in rapid deterioration of the cuttings. A less intense detrimental influence was also noted when the cuttings were held with the bases in water at 90° to 100° F., for

one hour. Early rotting of the stem bases followed treatments with hot water. When the bases of cuttings were placed in ice water (32° F.) for a day, survival was much better than in the case of cuttings placed in hot water, but the results were not as satisfactory as those of untreated control cuttings. All preliminary hot or cold water treatments were dispensed with during the winter period although a number of pre-callusing tests in the sweat bench were tried as will be described later.

It was found that the resin exuded at the bases of fresh cuttings could be readily wiped off with a cloth moistened with 95 per cent.

TABLE 19.

Survival and rooting percentages of white pine cuttings from a 60-year old tree in November. The bases of one-half the cuttings were wiped with alcohol to remove resin before planting or treating with indolebutyric acid.

Treatment	Survival after:		Rooted
	90 days	120 days	
	%	%	%
Control .....	88	76	8.0
The same, with alcohol .....	88	56	4.0
I. B. in talc 1 mgm./gm. ....	84	60	12.0
The same, with alcohol .....	76	25	8.0
I. B. in talc 2 mgm./gm. ....	68	20	4.0
The same, with alcohol .....	40	8	4.0
I. B. soln. 10 mgm./l. ....	20	4	0
The same with alcohol .....	4	0	0
I. B. soln. 100 mgm./l. ....	4	0	0
The same, with alcohol .....	4	0	0

ethyl alcohol. A series of cuttings, Table 19, was treated with alcohol in the above manner and some of them given additional treatments with solutions and dusts containing indolebutyric acid. An early breakdown of the tissues at the stem bases occurred in many of the cuttings wiped with alcohol and callus formation was hindered. Appreciably lower survival occurred when the resin was removed in this manner than in the control series. No rooting occurred with cuttings given solution treatments with indolebutyric acid, but this chemical in talc had a slightly favorable influence on rooting.

With dormant cuttings of white pine placed in a warm green-

house the exudation of resin does not appear to present a difficult problem. In fact, the freshly wounded tissues at the cutting base are probably afforded protection from an early entrance of rot-inducing microorganisms by the flow of resin.

*The Callusing of White Pine Cuttings.* The formation of a basal callus is apparently a normal process with white pine cuttings after a variable period in the propagation bench. Further, it was observed that rooting never occurred in the absence of a callus and that the roots of cuttings from sapling and older trees emerged from the side of the callus and grew horizontally at right angles to the stem axis. But one instance was noted of a root emerging directly from the base of the stem and continuing growth in a downward direction. Callusing could be readily induced, but the initiation of actual rooting was much more difficult and uncertain. The history of hundreds of white pine cuttings revealed that while callusing was preliminary to rooting, it was an unreliable index as to what the rooting response would be, as all too frequently callusing was the only outward sign of developmental activity in these cuttings. In some species good callus formation is viewed as being negatively correlated with successful rooting. Knight (1926) found that the rooting of hardwood fruit tree cuttings took place more readily in sand, where callusing was less than in clay. Clark (1931) observed with *Cotoneaster* that successful rooting was usually associated with slight callus formation.

In the early part of this study many records were made of the appearance of callus tissue and its progress by digging up the cuttings and examining the stem bases. This was discontinued when it became evident that lifting the cuttings and replanting affected the cuttings adversely. In the open bench the formation of callus tissue was rather slow and not uniform on all cuttings of a lot. Usually 20 to 30 days elapsed before the callus tissue was conspicuous. Large cuttings produced proportionately larger calluses than small cuttings. In the sweat bench callus formation was evident within 5 to 7 days and substantial development of this tissue occurred in two weeks. Continuous treatment in the sweat bench favored the formation of large irregular calluses, but the foliage and stems of the cuttings were more subject to rotting.

To secure whatever benefits early and complete callusing might confer on white pine cuttings a number of series, see Tables 16, 17 and 20, were subjected to a pre-callusing period in the sweat

bench for 7, 10 or 20 days and then transferred to the open bench. This practice usually improved survival of the cuttings during the first three months as compared with those in the open bench. It definitely increased and speeded callusing and in some cases was associated with an increase in rooting. This method would then seem advantageous, provided of course, that prompt and large callusing definitely favors rooting. Callus formation appears to afford protection against attack by microorganisms causing rotting of the stem base. But when the resin sets in a hard crust with sand or when the callus is thoroughly suberized there is interference with the absorption of water.

TABLE 20.

Survival, callusing and rooting percentages of cuttings from white pine trees 15 years old in November, placed in the open bench or pre-callused for 20 days in the sweat bench.

Treatment		20	After:		
		days	50	90	150
		%	%	%	%
Open bench	{ Survived .....	100	92	57	20
	{ Callused .....	57	83	—	—
	{ Rooted .....	0	0	0	1.5
Pre-callused 20 days	{ Survived .....	100	89	64	20
	{ Callused .....	93	93	—	—
	{ Rooted .....	0	0	0	6.1

Indirect evidence of interference with absorption and conduction, caused by the resin-sand crust and callus formation, was secured through tests of the conduction of stains both by fresh cuttings and by those retained in the benches for various lengths of time. The conduction of thionin, methylene blue and eosin in freshly made cuttings could be detected throughout the stems and in the needles within three days. The rate was influenced by temperature and the relative humidity of the atmosphere. With cuttings in the bench 9 days callus formation had just started, but a crust of resin and sand had formed on the cutting bases. With these cuttings practically no conduction of stains could be detected in 6 days. After 20 days in the bench other cuttings had formed a callus completely covering the stem bases. With these no per-

ceptible conduction of stains was observed in 5 days. Shaving off a portion of the callus was followed by perceptible stain conduction. When the entire callus was removed from the original stem base, the conduction of stains was comparable to that occurring with freshly made cuttings.

*Waxing White Pine Cuttings.* In the late summer and early fall when much difficulty was experienced with rapid drying and death of white pine cuttings, several series were sprayed with the commercial preparation Dowax manufactured by the Dow Chemical Company,<sup>4</sup> of Midland, Michigan. In a report by Miller, Neilson and Bandemer (1937) on wax emulsions for spraying nursery stock reference was made to work by A. Laurie and L. C. Chadwick on the use of emulsified paraffins for the control of desiccation in cuttings. Evergreen cuttings of several varieties of *Taxus*, of *Illedera helix* and of other species were tested. The conclusion was reached that evergreen cuttings that root slowly may be aided by treating with wax emulsions. Preliminary correspondence with the Dow Chemical Company indicated that the action of Dowax on white pine cuttings was unknown.

Experiments carried on in September with white pine cuttings sprayed with an emulsion of Dowax indicated that this treatment had beneficial possibilities for cuttings planted outdoors, but in an open bench of a greenhouse some deleterious action was evident. Under greenhouse conditions a reddening and browning of needles occurred within the first month, accompanied by a tendency for the fascicles to absciss. The mortality of the treated cuttings indoors increased rapidly during the first three months. Outdoors the survival during the first three months was of the same order as that of the control cuttings, except for a slight reddening of the tips of the needles. Since none of the cuttings planted in September rooted no final results on the influence of this wax emulsion are available for these series.

In October, several series of white pine cuttings were subjected to dipping of the cutting bases into melted paraffin at 180° F. followed by the removal of a thin section from the stem base. This treatment did not produce any observable immediate injurious effect, but considerable deterioration of the cuttings occurred

<sup>4</sup> Thanks are given to the Dow Chemical Company for a generous sample of Dowax.

within the first three months. During the winter season waxing procedures were dispensed with, but greater emphasis was placed on the maintenance of higher atmospheric humidities to overcome severe desiccation of the cuttings.

*The Propagating Medium.* Although the most commonly used propagating medium for cuttage work is sand, there is a diversity of opinion among propagators regarding the choice of this medium or of peat or sand-peat mixtures for certain subjects. Usually the preference for a given medium is based on the results of practical experience and in some cases on controlled tests with various subjects. Only a few references to this phase of plant propagation will be cited. In Scotland, Stewart (1927) maintained that clean sharp sand proved most satisfactory for rooting most kinds of cuttings, and this view is in accord with many practical propagators whom the writer has consulted. Kains (1931) advocated the use of fairly coarse sand, but later Kains and McQuestion (1938) mentioned the desirability of peat moss for certain subjects and listed the characteristic features of sand and peat moss. Both Zimmerman (1926) and Laurie (1928) favored a mixture of peat moss and sand because of the increased water-retaining property; and the former noted the possibility that peat moss contains some substances stimulating plant growth. Hubert, Rappaport and Beke (1939) tested ten media with many species and concluded that peat and sand or peat alone were best. The beneficial effects of peat were considered to be due to stimulating substances which it contained.

In view of these and other somewhat controversial results and recommendations it was considered necessary to test, under our conditions, sand, a mixture of sand and peat, and peat alone. Sand had been found quite satisfactory with cuttings of Norway spruce (Deuber and Farrar, 1940), but the cuttings of white pine presented more serious problems in that they required a longer period in the propagation bench and had a much greater tendency to dry out or to rot. A comparison was made of sand, of a mixture of sand and peat consisting of equal volumes of these materials, and of peat alone. Finely divided German peat was used. Cuttings were placed in these media in wooden flats, and another lot of cuttings was placed in sand in the open bench. The data of this experiment, Table 21, indicated that survival during the first three months was most satisfactory in the sand in the open

bench, followed by the sand-peat mixture, and sand. The flats were not found as satisfactory as sand placed directly on the tile bottom of the bench. Early in the experiment cuttings in the peat began to rot and a white filamentous fungus became very abundant. At the end of five months the cuttings placed in sand in the open bench showed the same low survival as those in the sand-peat mixture, while all cuttings in peat alone had died.

The method followed by Stoutemeyer, Jester and O'Rourke (1940) of pre-callusing black locust cuttings by wrapping bundles of them in sphagnum and placing them under conditions of relatively high temperature and humidity was also tried. These conditions caused white pine cuttings to callus promptly, but rotting of the stem bases was rapid and severe.

As a clean, well-aerated and easily handled medium seemed highly desirable, it was decided to continue using fresh, washed

TABLE 21.

Survival and rooting percentages of cuttings from white pine trees 30 and 35 years old, collected in October and planted in an open bench with sand and in flats with sand, sand-peat and peat.

Medium	50 days	Survival after		150 days	Rooted
	%	90 days	120 days	%	%
Open bench, sand .....	100	56	22	5	0
Flats with:					
Sand .....	82	39	11	2	1.5
Sand-peat .....	77	44	18	5	0.7
Peat .....	67	21	3	0	0

sand as the chief medium. Infection by fungi and other rot organisms was not wholly eliminated but was much less than with peat. Sand with proper management in watering and control of atmospheric humidity did permit carrying some of the mid-winter series of dormant cuttings for periods of six to seven months. The susceptibility of white pine cuttings to rotting makes elimination of organic matter in the propagating medium appear desirable.

*Greenhouse Environments.* Reference has previously been made to the superior survival of summer cuttings of white pine in an outdoor frame to those in the greenhouse. While no rooting

occurred under either condition this may have been due to seasonal features of development existing within the cuttings. In the autumn and early winter wide differences in cutting survival occurred between cuttings in the main room and those in the center section of the greenhouse. Variation in survival was also observed between cuttings in benches with different exposures. The greatest variation in survival was between cuttings placed near or away from the outer glass wall in the same row across a bench. The fact that cuttings placed near an outer wall rooted poorly was explained by Hubert, Rappaport and Beke (1939) as being due more to a lower light intensity than to a lower temperature. A detailed study of such micro-climatic features was not attempted in the present investigation, but it was found that white pine cuttings nearer the outer wall dried out earlier than those more remote. Since a space of 4 inches separated the bench from the wall it appears possible that warm air rising from the steam pipes below the bench may have been responsible for higher transpiration rates in the outermost cuttings. The center section of the greenhouse bounded on the east by the unheated cold room and on the west by the main room had temperatures a few degrees colder than the main room and it was evident from December to the spring months that cuttings survived considerably better in this cooler section than in the main room.

In December and the following three months comparable series of cuttings were placed in the open bench or in a sweat bench, and from January on other series were placed in the cold room in a bench heated by an electrical heating unit. The data on survival and rooting, Table 22, for these three environments indicated that greenhouse conditions with an average temperature of about 70° F., were most satisfactory for survival and rooting. In December, temperatures between 74° to 84° F., prevailed together with a high relative humidity in the sweat bench. These warm, moist conditions promoted rapid callusing of the cuttings, but rotting set in early and caused a large increase in the mortality rate. Through January and later the top sash of the sweat bench was left partially to entirely open. Under these conditions the sand still was two or three degrees higher in temperature than that in the open benches and the high walls of the sweat bench afforded more humid conditions than prevailed in the open benches of the greenhouse. The increased ventilation of the sweat bench appeared



responsible for the increase in survival recorded for the cuttings collected in January and February.

In the cold room the electric heating unit in the sand provided temperatures of 53° to 64° F. during the colder nights and days. The cuttings of various series survived very well, but callusing and rooting were greatly delayed when compared with the development made by cuttings handled in the warm greenhouse. Even

TABLE 22.

Survival and rooting percentages of white pine cuttings from trees 20 and 30 years old in midwinter and propagated under three greenhouse conditions.

Month collected and Bench condition	Survival after:					Rooted
	90 days	120 days	150 days	180 days	210 days	
Dec.	%	%	%	%	%	%
Open bench .....	94	94	84	—	40	14.0
Sweat bench .....	84	14	8	—	0	0
Jan.						
Open bench .....	98	—	78	26	—	6.0
Sweat bench .....	74	—	52	1	—	14.0
Cold room .....	80	—	60	1	—	6.0
Feb.						
Open bench .....	85	80	77	—	—	0
Sweat bench .....	100	100	92	—	—	7.5
Cold room .....	100	87.5	55	—	—	2.5

after six months, cuttings of older stock, though surviving in large numbers, rooted but slightly. Very good results were obtained with cuttings of 3-year old seedlings in January. In 180 days 70 per cent. of these rooted.

The best propagation conditions for dormant white pine cuttings are thus clearly provided by sand in open benches in a warm, moist greenhouse. An average temperature of approximately 70° F. and a relatively high average humidity of the atmosphere were the essential characteristics of this environment. Under these conditions early callus formation was induced, and root formation was promoted. These cuttings are relatively slow to establish themselves, requiring a minimum of three or four months for the appearance of the first roots. During this period the cuttings

must be maintained under conditions favorable for growth. Desiccation and rotting are the two most serious causes of death of cuttings. Interruption of normal growth or developmental activities by brief periods of high losses of water, by disturbance of the cuttings in the sand as when they are dug to be examined, and probably by other unrecognized unfavorable conditions, appear to result in a cessation of root formation. Many cuttings were found to callus and then to remain practically unchanged for five to seven months. The maintenance of constantly favorable environmental conditions cannot be overemphasized as an essential requirement for the successful propagation of white pine cuttings.

*Anatomical Aspects of Root Formation by White Pine Cuttings.* During the course of this investigation Dr. M. R. Jacobs<sup>5</sup> made sections of white pine cuttings at various stages of callus formation and of root regeneration. The cuttings propagated in sand offered many difficulties to satisfactory sectioning because of the inclusion of sand grains. However, it was possible to reconstruct the general sequence of events as the cuttings callused and rooted. This record though preliminary in nature has helped to reach a clearer understanding of the rooting process. Additional studies on the anatomical aspects of the root regeneration process are greatly to be desired.

The current twigs of white pine used as cuttings consist of a central pith surrounded by xylem cells, cambium, inner and outer barks. The pith is evident and composed of large parenchyma cells. The tracheids of the xylem which are aligned in the long axis of the twig are thick walled and soon become lignified. Bordered pits occur in the walls of the xylem cells. Narrow medullary rays composed of parenchyma cells and horizontal tracheids traverse the xylem. Vertical resin ducts are present in the xylem and inner bark. The xylem is surrounded by the primary cambium and the inner bark tissues. Outside the inner bark the cork cambium occurs followed by the cork tissue of the outer bark. On severing the cutting from the branch resin exudes abundantly from the large resin ducts of the inner bark and appears to seal the cutting base, perhaps giving protection for a time against the entrance of microorganisms.

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<sup>5</sup> Thanks are extended to Dr. M. R. Jacobs for the interest and assistance given to this phase of the present study.

The first tissue of the cuttings in the propagating bench to become active was the phellogen or cork cambium. Newly divided cells derived from the phellogen emerge from the base of the cutting and extend over the base and around the periphery, eventually encasing the entire base. The callus tissue thus formed is composed of very large, thin-walled cells, at first white to cream colored and more or less spongy in consistency. In time, the outer layers of callus cells become brown as suberization occurs. Activity of the phellogen continues for some time to form new cells from within, forcing the previously proliferated cells farther and farther out, thus producing an irregular shaped mass at the cutting base and extending up the stem for 2 to 8 millimeters.

During callus formation or after it has reached a certain stage of development active cell division starts in certain cells of the cambium. Sections near the cutting base revealed newly formed tracheids characterized by a large number of bordered pits in the walls. Only rarely were the new cells in the region of the cambium organized into root primordia in cuttings from mature trees. More frequently, the newly generated cells were twisted and swirled in an abnormal manner as if they had been subjected to pressure when in a state of growth. Along the periphery of the wood at the cutting base irregular, jagged projections of hard, lignified tissue appeared just within the callus. During the winter period when callusing occurred promptly there was much evidence of the formation of these projections of lignified tissue at the cutting base. They were readily seen by peeling off the callus. All the sections showed these projections to be composed of swirled, appressed cells with many bordered pits. This tissue appears to be "wound" wood similar to that described by Sledge (1930) for cuttings of apple, sycamore and *Sambucus*. Sledge considered the formation of "wound" wood to be of no importance to root production. With white pine the "wound" wood was most frequently encountered in callused cuttings that did not root.

No satisfactory series of sections were secured of the stages of root primordia formation because of the irregular and unpredictable rooting responses obtained with cuttings of older trees. In this class of cuttings the root emerged from the side of the cutting usually at the upper limit of the callus and grew horizontally for one to three months. Figures 1 to 5, Plate IV, show typical initial roots of white pine cuttings. Only rarely did a root

emerge directly from the base of the cuttings and grow downward. Almost invariably a single root emerged from the callus of cuttings from the older trees. This fact indicates either a sparse induction of root primordia within the stem base or an inhibition in development or emergence of additional roots. Surrounding tissues may prevent normal orientation and emergence of newly formed roots. The emerging root is relatively large, 2 millimeters or more in diameter, when it makes its appearance on the face of the callus, and then grows vigorously in length for several months. Figure 4 of Plate IV shows an emerging root. The production of branches by the first formed root usually occurred within the second or third month.

The length of time required for the first appearance of a root on cuttings of older pine trees, from three to six months, appears to indicate that no preformed root primordia exist in the stem cuttings. In one-year old apple root cuttings Siegler and Bowman (1939) found that shoot primordia were generally more completely organized than root primordia so that shoots emerged more rapidly than roots in certain clones. This condition was suggested as accounting for the mortality in those clones in which the top growth had inadequate support, owing to the lack of roots. The length of time required for the organization of root primordia in white pine cuttings may permit the lignification of proliferated cells from the cambium or advanced suberization of callus tissue, thus hindering or entirely repressing root emergence.

*Summation of the Features which were associated with or promoted the Rooting of White Pine Cuttings.* To review and evaluate the results of the numerous experiments with white pine cuttings the data of all the series in which a rooting percentage of 10 per cent. or over was obtained have been collected in Table 23. The value of 10 per cent. as a criterion of positive rooting eliminates consideration of many series in which but one or two cuttings rooted and also the series collected during the summer period. Since age of the parent stock is a primary factor controlling the rooting capacity of white pine cuttings, the items in this table have been arranged according to the age classes studied. Month of collection and type of treatment are also indicated.

Cuttings secured from seedlings 2, 3 and 4 years old rooted more promptly and in higher percentages than cuttings secured from older trees. The tests were not sufficiently numerous to indi-

TABLE 23.

Summary of the series of white pine cuttings which rooted 10 per cent. or more and the number of days in the propagating bench.

Collect.	Age of trees and treatment	Root.	Days
<i>2 years</i>		%	
Oct.	Control .....	22.5	180
Nov.	Control .....	32.5	150
Dec.	Control .....	20.0	150
Jan.	Control .....	30.0	120
Jan.	Sweat bench, cold room .....	22.0	90
Feb.	Control .....	93.3	120
Mar.	Control .....	32.5	90
June	Control .....	21.0	77
<i>3 years</i>			
Jan.	Pre-callused 8 days .....	13.3	100
Jan.	Pre-callused, talc + I. A. 4 mgm./gm. ....	10.0	100
Jan.	Sweat bench, cold room .....	53.3	180
Jan.	Open bench, cold room .....	70.0	180
<i>4 years</i>			
Feb.	Control .....	69.0	140
Feb.	Hormodin No. 1 .....	73.8	140
Feb.	Hormodin No. 3 .....	78.5	140
<i>5 years</i>			
Feb.	Control .....	26.4	140
Feb.	Hormodin No. 1 .....	26.4	140
Feb.	Hormodin No. 3 .....	38.2	140
<i>7 years</i>			
Jan.	Pre-callused 8 days .....	26.6	180
Jan.	Pre-callused, talc + I. A. 4 mgm./gm. ....	10.0	180
Jan.	Sweat bench, cold room .....	30.0	180
Jan.	Open bench, cold room .....	26.6	180

cate a proportional decrease in rooting with increase in age, from 2 to 4 years, of parent stock. Cuttings from seedlings of these three age classes showed a uniformly high rooting capacity. Cuttings from 5 and 7 year old trees rooted to a considerably lesser extent than those from younger age classes. A rather sharp decrease in rooting capacity was found in cuttings from trees five years old. This would seem a very serious obstacle to the propa-

TABLE 23 (cont'd)

Collect.	Age of trees and treatment	Root.	Days
15 years		%	
Dec.	Hormodin No. 3 .....	10.0	120
Dec.	Talc + I. A. 4 mgm./gm. ....	10.0	150
Dec.	Talc + Nap. 4 mgm./gm. ....	12.0	150
Feb.	Hormodin No. 3 .....	10.0	180
Mar.	Control, clone 853 .....	10.0	120
Mar.	Control, clone 854 .....	10.0	105
Mar.	Control, clone 859 .....	10.0	105
Mar.	Control, clone 861 .....	25.0	120
Mar.	Control, clone 865 .....	20.0	105
25 years			
Dec.	Control .....	14.0	210
Dec.	I. B. soln. 10 mgm./l. ....	10.0	210
Dec.	Talc .....	10.0	210
Dec.	Talc + I. B. 1 mgm./gm. ....	10.0	210
Dec.	Talc + I. B. 4 mgm./gm. ....	12.5	210
Dec.	Char. + I. B. 4 mgm./gm. ....	10.0	210
35 years			
Jan.	Sweat bench .....	14.0	180
Jan.	I. B. soln. 2.5 mgm./l. ....	13.3	180
Jan.	I. B. soln. 10. mgm./l. ....	13.3	180
Jan.	I. B. soln. 100. mgm./l. ....	26.6	150
Jan.	Talc + I. B. 1 mgm./gm. ....	10.0	180
60 years			
Nov.	Talc + I. B. 1 mgm./gm. ....	12.0	120
Feb.	Hot water, 90° F., 1 hr. ....	10.0	150
Feb.	Control, clone 188 .....	30.0	150
Mar.	Control, clone 188 .....	20.0	105
Mar.	Talc + I. B. 4 mgm./gm. ....	30.0	120
Mar.	Talc + I. A. 4 mgm./gm. ....	15.0	120

gation of this species by cuttings in large quantities because the four-year or younger stock is too small in size to yield many cuttings per tree and also because the juvenile stock may not yet show characteristics denoting desirable clonal variations.

Although great numbers of cuttings from vigorous 15-year old trees were taken and variously treated the rooting responses were low. These cuttings would form a *callus* promptly and survive

three months or more, but rooting was limited. These 15-year old trees were of a size and age which permitted the collector to judge of their qualities.

Though not entirely lost, the rooting capacity of the cuttings of older trees, 20 to 60 years of age, is greatly diminished and irregular. The low and scattered rooting in a number of series of cuttings from these older trees may indicate an inherent or retained capacity to root of cuttings from but a few clones included in the random collections.

The seasonal record of the rooting responses secured with white pine cuttings was not sharply defined like that obtained with Norway spruce cuttings. The cuttings from seedlings and older white pine trees rooted at least to some extent from collections made from October through the winter to April. The data with older trees do not permit pointing to any one peak month for collecting cuttings. A partial explanation appears to be the length of time required for the initiation of the development of root primordia. If the rooting responses in less than 100 days were taken as a criterion of positive rooting it would eliminate all but a few of the youngest seedling classes. Four months and even six months must often elapse before a fair appraisal of rooting can be made in cuttings from the older age classes. This slow formation of roots is a handicap to the successful rooting of white pine cuttings, for it necessitates the maintenance of non-rooted cuttings in a viable state over long periods in which desiccation and infestation with rot organisms constantly threaten.

Chemical treatments for inducing root formation were effective in relatively few instances. The increases in rooting response attributable to the chemical treatments employed were not consistent nor of large magnitude. Instances of toxic action at the cutting base with root formation occurring above the injured zone were observed. The long period required before roots emerge from cuttings of older white pine stock may require special techniques or repeated treatments to secure effective responses with the root inducing chemicals now in general use.

In the selection and preparation of the cuttings it was found that small to medium size cuttings, 2 to 4 inches long, made from lateral twigs were better able to survive and were more likely to root than longer cuttings. Long, vigorous terminal shoots of lateral branches were unsatisfactory when made into cuttings.

Trimming off basal needles was distinctly harmful. Removal of resin from the stem base with hot water or alcohol usually led to early rotting of the cuttings. The cuttings should be disturbed as little as possible after being planted.

Although the indications are not entirely clear, it appears probable that a brief pre-callusing period of three to ten days in the sweat bench would be stimulating to the cellular activities involved in root regeneration. On this point further anatomical study is required.



## RED PINE

In late November, cuttings of red pine, *Pinus resinosa*, Sol., were taken from trees 30 years old, and, in January, from trees 20 years old. A copious exudation of resin occurred from the bases of these cuttings which were large, being 5 to 8 inches long. Rows of cuttings were placed in the open benches in the main room, in the cold room and in the sweat bench. In the sweat bench and to a lesser extent in the open bench of the warm greenhouse callus formation proceeded rapidly during the first three weeks. However, after the callus formed very little additional development occurred. On the contrary, the stem bases began to rot and the needles turned yellow, becoming reddish brown as desiccation advanced. Cuttings in the cold room formed slight or no calluses. Though they retained green foliage for three to four months, eventually dried out and died. No rooting of the red pine cuttings was observed.

## LACE BARK PINE

One collection of 40 cuttings of a 10-year old specimen of lace bark pine, *Pinus bungeana* Zucc., was secured in January. These were placed in the ventilated sweat bench. Within a month an excellent layer of callus had formed and one cutting had a root 5 millimeters long. Four others had roots in the process of emerging. The cuttings were then transferred to the open bench. In May, or after 4 months, 52.5 per cent. of the cuttings had developed excellent, long, well-branched root systems, see Figure 1, Plate VII. This species is listed among the conifers which Kirkpatrick (1940) has found to respond to solution or powder treatments with indolebutyric acid.

## JAPANESE RED PINE

In December cuttings were collected from four Japanese red pines, *Pinus densiflora* Sieb. & Zucc., 15 years old and bearing a heavy crop of cones. The presence of these reproductive structures gave a timely opportunity to see if they influenced the capacity of the cuttings to root. Jacobs (1939) had met with complete

failure in his attempts to root cuttings of Monterey pine bearing terminal buds containing male-cone primordia. Two groups of cuttings were taken from the Japanese red pine trees, one from branches bearing pistillate cones and another from branches with no cones present at the time.

The cuttings were placed in sand in the open bench. In 90 days callusing and some rooting had occurred. One of the rooted cuttings of the group originally assumed to be non-cone bearing actually had a staminate cone open and shedding pollen. None of the other supposedly non-cone bearing cuttings produced cones. This exceptional case is in direct variance with the general results of Jacobs' investigation referred to above. After six months, when the final records were taken, rooting in the cone-bearing group was 25.7 per cent. and in the non-cone bearing group 17.1 per cent. Root systems of Japanese red pine are illustrated in Figure 3, Plate VII. Since cones are borne abundantly by the Japanese red pine at an early age, this species will be found especially useful in experimental work designed to show the correlation between the presence of reproductive organs and the rooting capacity of cuttings.

## HEMLOCK

Cuttings of hemlock, *Tsuga canadensis* (Linnaeus) Carrière, were made in November from four-year old trees and from 20-year old trees. Tests of the rooting responses of this material were made in the open bench, in the sweat bench, and in the cold room. Also, one dust treatment with 4 mgms. of indolebutyric acid per gram of talc was tried. In the sweat bench callusing was slightly better than in the open bench with the cuttings from juvenile stock in the first 90 days; and in this initial period none of the cuttings from the older stock rooted.

The survival and rooting of the cuttings in six months is tabulated in Table 24 and typical root systems of this species are illustrated in Figure 2, Plate VII.

Through the whole period of propagation marked differences were observed between the cuttings of the two age classes, those from four-year old stock rooting much more freely, with and without chemical treatment, than those from the 20-year old stock. With the cuttings from the juvenile stock the sweat bench treatment promoted rooting somewhat better than the open bench treat-

ment, but the survival of the cuttings was reduced. In the cold room rooting was very slow in starting and although 85 per cent. of the cuttings from the juvenile stock rooted, in the six months' period, their roots were much smaller and less abundant than those of cuttings handled in the warm greenhouse. Significant increase in the numbers rooting and improvement in the quality of root systems occurred with cuttings of both age classes when treated with indolebutyric acid mixed with talc. These results were among the best that were obtained in this investigation of the beneficial effect of chemical treatment during vegetative propagation.

*Influence of Vitamin B<sub>1</sub> upon Rooted Cuttings.* It is the initial rooting habit of cuttings from older stock of white pine, Norway

TABLE 24.

Survival and rooting percentages of cuttings from two age classes of hemlock trees after 180 days.

Treatment	4-year old stock		20-year old stock	
	Survived	Rooted	Survived	Rooted
	%	%	%	%
Open bench, control .....	57.5	37.5	65.0	5.0
Open bench, I. B. in talc 4 mgm./gm... ..	92.5	92.5	97.5	65.0
Sweat bench .....	47.5	42.5	75.0	2.5
Cold room .....	97.5	85.0	100.	10.0

spruce and hemlock to form one thick, unbranched root. Occasionally two or more such roots are formed. After a variable time, with the addition of secondary and tertiary roots, well branched root systems satisfactory for transplanting are normally formed. Since Bonner and Greene (1939) have shown that various species of plants in sand culture respond with marked increases in the rate of dry weight accumulation when vitamin B<sub>1</sub> was supplied, it was of interest to know if additions of this vitamin would improve the rate of growth of coniferous cuttings and particularly of their roots.

Late in March a large number of rooted cuttings of hemlock trees four years old and Norway spruce trees forty years old were available. The cuttings were selected for uniformity of tops and roots and divided into lots of 20 each. The roots of one series of each species were placed in a solution of vitamin B<sub>1</sub> containing 1 mgm. per liter of tap water for 30 minutes. These and untreated

control cuttings were planted in flats of sand and watered each week with a nutrient solution. The cuttings initially placed in a solution of vitamin B<sub>1</sub> were given additional waterings with the vitamin solution at weekly intervals for six weeks. After four months the cuttings were dug and examined.

The hemlock cuttings in the series treated with vitamin B<sub>1</sub> were visibly improved in the quality of both tops and root systems. More lateral shoots were developing, and the growth of the terminal shoots was somewhat greater than in the control cuttings. Measurable improvement of the root systems is recorded in Table

TABLE 25.

Comparison of the root systems of rooted cuttings of hemlock and Norway spruce trees untreated and supplied Vitamin B<sub>1</sub> in sand. Averages based on 20 cuttings in each series.

	Hemlock		Norway spruce	
	Control	Vitamin B <sub>1</sub>	Control	Vitamin B <sub>1</sub>
Avg. number of secondary roots per cutting .....	5.00	5.25	5.20	4.40
Avg. length of the 4 longest secondary roots per cutting—cm. ....	10.97	14.18	16.93	15.07
Avg. fresh weight per root system—gm.	0.80	0.96	1.77	1.40

25. In number of secondary roots, length of secondary roots and fresh weight of entire root systems the cuttings treated with vitamin B<sub>1</sub> surpassed the controls.

Neither top nor root development in the Norway spruce cuttings was positively influenced by the treatment with vitamin B<sub>1</sub>. As yet the explanation of the different manners in which the hemlock and Norway spruce cuttings respond to treatment with vitamin B<sub>1</sub> is largely conjectural.

## GENERAL DISCUSSION

In this study of vegetative propagation with stem cuttings of coniferous trees the attempt has been made to identify the major controlling factors and to arrive at some understanding of their action. Most of the experimental work was concerned with cuttings of Norway spruce and eastern white pine. Additional observations were made with cuttings of red pine, lace bark pine, Japanese red pine and hemlock. The production of roots occurred on the cuttings of all these species with the exception of red pine. With Norway spruce cuttings information is now adequate for undertaking large scale vegetative propagation.

The search for successful methods by which high percentage of root regeneration may be secured from coniferous cuttings has proceeded along various lines. Seasonal responses have been tested, the characteristic potentialities of cuttings from both young and old trees have been determined, various methods of preparing the cuttings have been tested, and the most favorable propagating conditions have been sought. Numerous tests of the effectiveness of various physical and chemical treatments have been made.

Considerable variation was found in the rooting responses secured from many comparable collections of coniferous cuttings. There was some slight difference in rooting response between Norway spruce cuttings taken from a given plantation one year and similar cuttings taken the following year. Even greater variation occurred with cuttings of Norway spruce and eastern white pine taken in the same year from different plantations. Furthermore, marked variation in rooting response was noted between cuttings taken from individual trees in the same plantation and in the same year and season.

Dormant cuttings of Norway spruce or eastern white pine collected in the winter period were more satisfactory than cuttings collected in the spring, summer or fall. Japanese red pine, lace bark pine and hemlock cuttings collected during the winter period rooted satisfactorily, but no tests were made of cuttings taken during other seasons. With the cuttings from Norway spruce trees 40 years old the rooting capacity increased from zero in September to a maximum (80 per cent.) with cuttings collected in December and then declined. The seasonal rooting potentialities of

eastern white pine cuttings were more difficult to evaluate because of the generally lower and less consistent rooting responses obtained from cuttings of that species, compared with those of Norway spruce. The indications were, however, that the rooting capacity of eastern white pine cuttings increased from mid-winter until early spring.

The age of the parent tree proved to be a very important controlling factor in the rooting of coniferous cuttings. Cuttings of juvenile age classes of Norway spruce, eastern white pine and hemlock trees rooted more abundantly and more promptly than cuttings from trees of older age classes. Cuttings of juvenile age classes also responded to root-inducing chemicals more positively than those from older trees. A rather definite transition from a relatively high rooting response in cuttings from four-year old eastern white pine trees to a moderate rooting response in cuttings from five-year old trees was found. For the complete understanding of the underlying causes of this distinct variation in rooting capacity an intensive anatomical and morphological study is required.

Of considerable interest was the discovery that marked differences in the rooting capacity exist between cuttings secured from different clones of Norway spruce and white pine. Whether one is dealing with a retained rooting capacity in certain clones and not in others, or with differences in genetically inherited characters, was not determined. The fact that the cuttings of some old trees, even in species difficult to root, will occasionally regenerate roots can not be lightly disregarded, since there is always the possibility that trees possessing desirable characters may also possess the ability to reproduce vegetatively. This would apply in particular to white pine trees resistant or immune to white pine blister rust.

Tests of the effectiveness on the coniferous cuttings used in this study of various chemical treatments known to induce rooting in many species of plants were negative in the main. The results with these treatments were not uniform, and, with the exception of hemlock cuttings, did not produce significantly higher rooting responses. Eastern white pine cuttings appear more likely to respond to chemical treatments than the cuttings of Norway spruce trees.

It was found profitable to search for methods of preparing the cuttings and controlling propagation conditions that would assure survival and allow internal developmental events to run their nat-

ural course. This involved tests of cutting size, the use of axial or lateral shoots, trimming of basal needles, removal of resin, waxing the foliage, etc. Warm greenhouse temperature and possibly a brief initial treatment in the sweat bench appeared advantageous in the handling of eastern white pine cuttings. Desiccation and rotting of stem bases were the greatest threats to the survival of eastern white pine cuttings.

The only species with which no rooting occurred was red pine, but the trials with cuttings of this species were too limited to permit any authoritative statement regarding its rooting capacity. With hemlock cuttings the age factor was found to be important. Treatment of hemlock cuttings with indolebutyric acid in talc were more effective with cuttings from a juvenile age class than with those from trees 20 years old. In several tests that were made of dormant cuttings from lace bark pine and Japanese red pine, satisfactory rooting occurred in sand without special treatment.

## SUMMARY

### *Norway spruce cuttings:*

Marked increase in rooting capacity was found in cuttings from trees 40 years old, starting with material collected in October, reaching a maximum with material collected in December, and declining with material collected during the spring months.

Cuttings from two-year old white spruce and five-year old Norway spruce showed less seasonal trend in their rooting responses than cuttings from older age classes.

No consistent or highly significant increase in rooting was induced by treatments with chemicals such as indolebutyric acid.

Warm greenhouse temperatures with sand as the propagating medium sufficed to assure root formation taking place in 100 days during the winter period.

Both intact and disbudded cuttings rooted, the latter, when collected in May, showed higher rooting capacity than intact cuttings.

The rooting of cuttings from trees infested with spruce gall aphid was generally less than that of cuttings from non-infested trees.

Marked clonal variation in rooting capacity of cuttings from older trees was discovered. Marked differences were also found between the types of initial root systems produced by various clones.

### *Eastern white pine cuttings:*

Dormant cuttings rooted better than summer cuttings. No marked winter seasonal trend, as found with Norway spruce cuttings, was observed.

Cuttings from juvenile age classes, especially from seedlings two to four years old, rooted to a greater extent and more consistently than cuttings from older trees. Some rooting occurred with cuttings from trees 5, 7, 15, 18, 25, 30, 40 and 60 years old.

The indications were that cuttings from clones of older trees varied considerably in rooting capacity.

No consistent or highly significant beneficial effects were found when cuttings were treated with indolebutyric acid or similar chemicals.

Small cuttings, 2 to 4 inches long, taken from lateral twigs,



survived better and rooted more abundantly than larger cuttings, especially those taken from terminal shoots.

Trimming lower needles from the cuttings before planting reduced their survival and rooting.

Ringling the branches before severing the cuttings from the tree may be a beneficial practice, but more tests are required to establish the fact.

Superior results were obtained when the resin exuding at the stem base was not removed.

No advantage, but rather injury in varying degrees of severity, resulted when the cuttings were waxed.

Sand was found to be superior to peat, or a mixture of sand and peat, as the propagating medium.

Warm greenhouse temperature following a brief pre-callusing period in the sweat bench was found preferable to continuous sweat bench or cold room environments.

A brief description of the anatomical aspects of rooted white pine cuttings is given.

#### *Red pine cuttings:*

No rooting occurred in the limited trials that were made.

#### *Lace bark pine cuttings:*

One collection of cuttings in January from a tree ten years old rooted 52.5 per cent. when planted in sand in the warm greenhouse.

#### *Japanese red pine cuttings:*

One collection of cuttings in December from trees 15 years old rooted 25.7 per cent. when taken from branches bearing ovulate cones, and 17.1 per cent. when taken from branches without cones.

#### *Hemlock cuttings:*

Cuttings from trees four years old rooted to a much greater extent than cuttings from trees 20 years old.

Dust treatments with indolebutyric acid induced significantly higher rooting in the cuttings of both age classes than was observed in the control cuttings.

Vitamin B<sub>1</sub> improved the growth of stems and roots of rooted cuttings of hemlock but not of Norway spruce.

## CONCLUSIONS

The results of this investigation mark an advance in the knowledge of the feasibility of propagating certain species of conifers through the use of stem cuttings. The development of roots occurs more readily in the cuttings of some species than in those of others, and the process is influenced by a number of internal and external factors and conditions. The factors of greatest significance appear to be the season of the year at which the cuttings are collected, the age of the parent stock, and clonal variation in rooting capacity. The extent of the rooting response is influenced by the type of cutting, the preparation and initial treatments of the cuttings and the propagation environment. With but one species, hemlock, were treatments with a root-inducing chemical, indolebutyric acid, significantly effective. Since the developmental events leading to root regeneration in cuttings of conifers require relatively long periods in the propagation bench, every effort should be made to assure survival of the cuttings and prevent rotting. The season of collection has a very marked influence on the rooting response with cuttings of Norway spruce trees 40 years old. Cuttings secured from juvenile trees root more promptly and to a greater extent than those from older trees. Also, the season at which the cuttings are taken from juvenile trees is not as important as the season for making cuttings from older trees. Clearly, for juvenile and older spruces, the hot summer months are the least favorable for making cuttings for propagation. The wide clonal variation in rooting capacity that was found to exist in trees of the same species must be regarded as a factor of great importance in any attempt to multiply highly desirable trees with special characteristics. Large scale propagation of Norway spruce trees from parent stock varying widely in age is possible. Further experimental work will be necessary if satisfactory methods for the vegetative propagation of eastern white pine from parent trees over four years of age are required.



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**PLATES I - VII**

## PLATE I.

FIGURE 1. Rooted cuttings of white spruce seedlings, 2 years old, collected in January and photographed in May, 1940. Note the abundance of fibrous roots.

FIGURE 2. Rooted cuttings of Norway spruce trees 40 years old collected in January and propagated in an open bench in the warm greenhouse. This photograph and those of Figures 3 and 4 were made after the cuttings had been in the propagating benches 100 days.

FIGURE 3. Rooted cuttings of Norway spruce propagated in a sweat bench where the roots grew to great length.

FIGURE 4. Rooted cuttings of Norway spruce propagated in a cold room of the greenhouse. Heat was supplied by an electric heating unit in the sand. The roots were short and thick.



FIG. 2

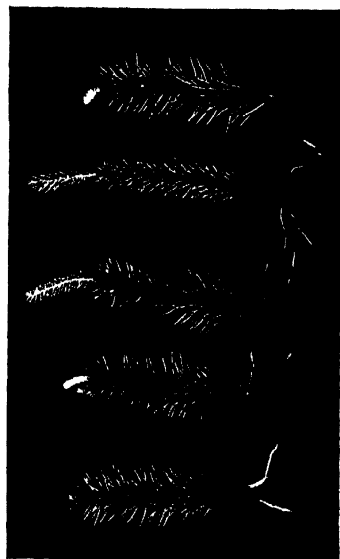


FIG. 4

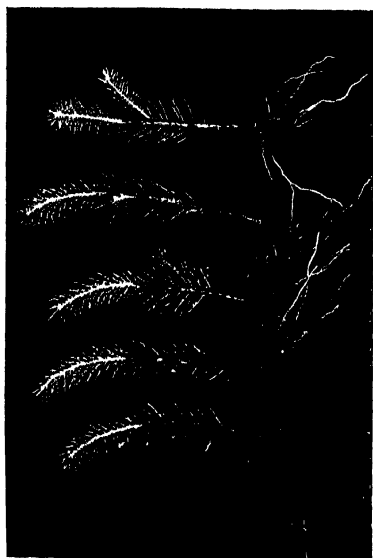


FIG. 1

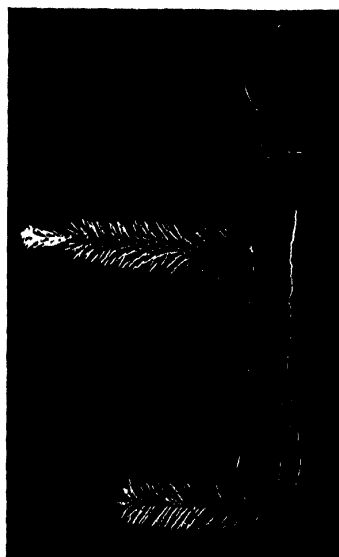


FIG. 3

## PLATE II.

FIGURE 1. Rooted Norway spruce cuttings of tree No. 13-5. These cuttings as well as those of Figures 2, 3 and 4 illustrate some of the more marked variations in root and shoot development associated with the cuttings collected from single trees. The trees were 20 years old. The cuttings were collected in May and photographed in August, 1939.

FIGURE 2. Rooted cuttings from tree No. 17-5. Long, sparsely branched and downward directed roots were characteristic of the cuttings of this tree.

FIGURE 3. Rooted cuttings from tree No. 16-5. Note the clustering of very short roots at the stem base with only an occasional long root.

FIGURE 4. Rooted cuttings from tree No. 15-5. One or two roots directed horizontally were characteristic of the root systems of this tree. Only slight development of terminal buds occurred in the cuttings in Figures 2 and 4.

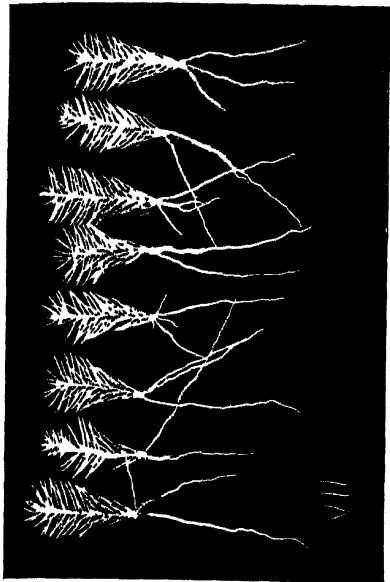


FIG. 1



FIG. 3



FIG. 4

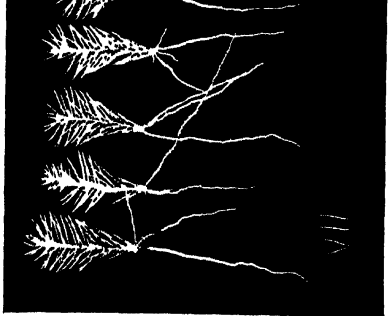


FIG. 2



### PLATE III.

FIGURE 1. In the rear row large white pine cuttings with dried needles oriented horizontally. Smaller cuttings in the front and center maintained turgid, upright needles.

FIGURE 2. Typical examples of injuries sustained by white pine cuttings in the propagating benches. Left to right, needles dry, flagged and leaf pigments faded; blackening and rotting of the stem base and lower needles; defoliation of lower needles with badly rotted bark removed; defoliation and rotting of the stem.

FIGURE 3. Limited root development of white pine cuttings from trees 30 years old, collected in August and photographed five months later. Defoliation and chlorosis are apparent in the tops.

FIG. 1



FIG. 2

FIG. 3



#### PLATE IV.

FIGURE 1. Rooted cuttings of white pine seedlings 2 years old planted in December, 1939, and photographed in April, 1940.

FIGURE 2. Rooted cuttings of white pine trees 30 years old planted in December, 1939, and photographed in May, 1940.

FIGURE 3. Rooted cuttings of a white pine tree 60 years old planted in November, 1939, and photographed in March, 1940.

FIGURE 4. Rooted cuttings of white pine trees 15 years old. The branches were ringed 30 days before the cuttings were collected in November, 1939. They were photographed in April, 1940. The cutting to the left has two roots just emerging from the basal callus.

FIGURE 5. Cuttings similar to those of Figure 4 except that during the first 20 days they were in the sweat bench.



FIG. 1

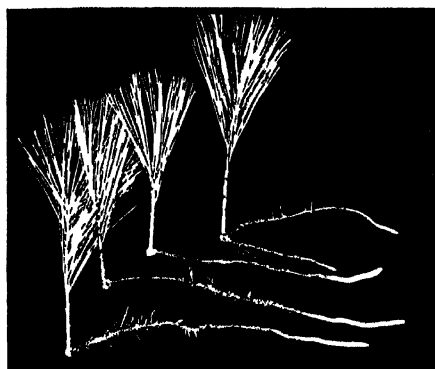


FIG. 2

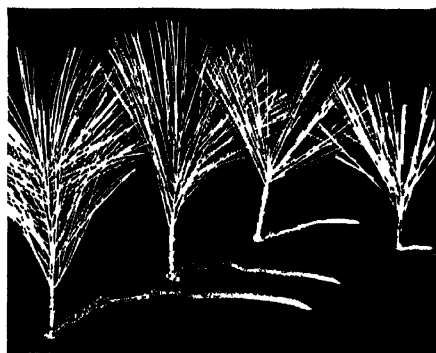


FIG. 3

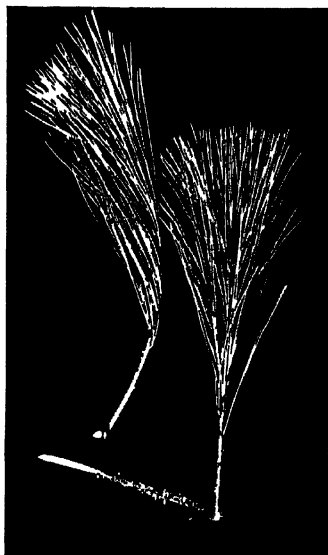


FIG. 4



FIG. 5

PLATE V.

FIGURE 1. Rooted cuttings of white pine transplants 4 years old planted in February with no initial treatment and photographed June 1, 1940.

FIGURE 2. Rooted cuttings of white pine transplants 4 years old similar to those of Figure 1 except that they were treated with Hormodin No. 1.



FIG. 1



FIG. 2

PLATE VI.

FIGURE 1. Propagating bench in the warm greenhouse in February with cuttings of Norway spruce, left, with new shoot growth evident, and on the right white pine cuttings.

FIGURE 2. Sweat bench with white pine and Norway spruce cuttings.

FIGURE 3. Outdoor, shaded propagating frame.

FIG. 1

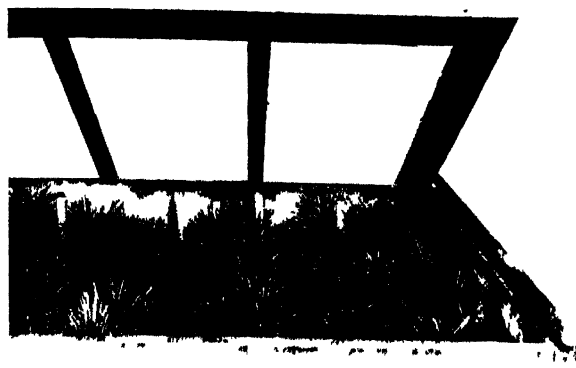
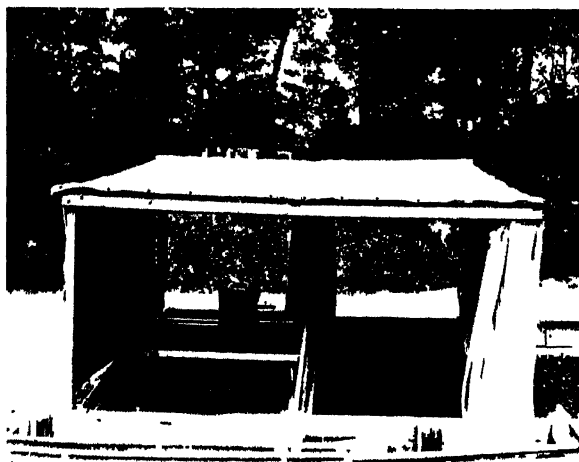


FIG. 2

FIG. 3





## PLATE VII.

FIGURE 1. Rooted cuttings of *Pinus bungeana* Zucc. collected in January, planted in sand without special treatment and photographed in May, 1940.

FIGURE 2. Rooted cuttings of *Tsuga canadensis* (Linnaeus) trees 4 years old collected in November, 1939, treated with indolebutyric acid in talc, 4 mgm./gm., and photographed in March, 1940.

FIGURE 3. Rooted cuttings of *Pinus densiflora* Sieb. and Zucc. collected from trees 15 years old, planted in sand without special treatment in December, 1939, and photographed in March, 1940.

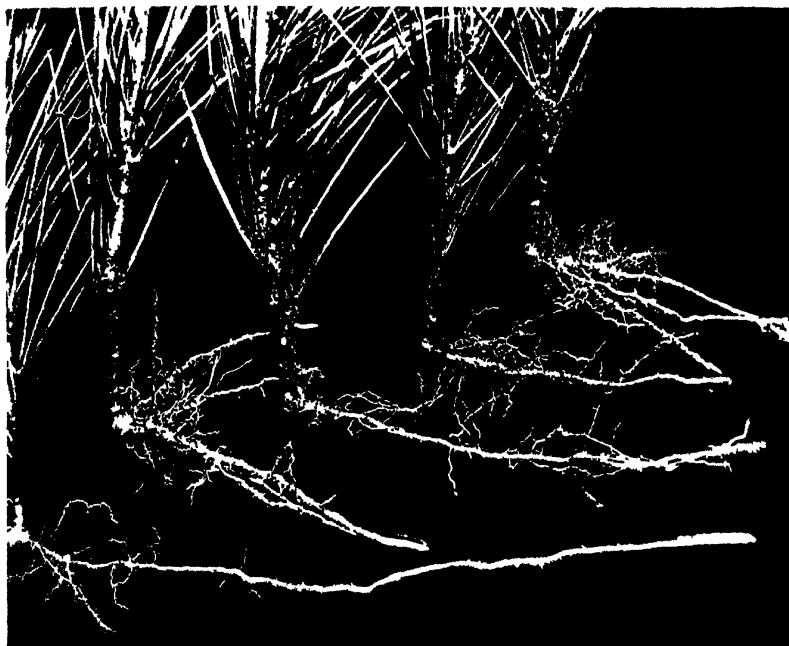


FIG. 1



FIG. 2



FIG. 3



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Control of Cedar-Apple Rust on  
Red Cedar

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# CONTROL OF CEDAR-APPLE RUST ON RED CEDAR

RUSII P. MARSHALL

## INTRODUCTION

The common rust of apples and cedars caused by the fungus *Gymnosporangium juniperi-virginianae* Schw. occurs almost universally throughout the United States east of the Rocky Mountains. Not only must this fungus grow on both hosts to complete its life cycle; it must do so alternately. On the cedars it causes the familiar "galls" or "cedar apples." If these are very abundant, they render the trees unsightly, injure the twigs, and affect the general vigor of the trees. On apple trees the fungus spots the leaves, twigs and fruit, induces defoliation and reduces fruit production. The cedar-apple rust is so common and so conspicuous that it is probably better known to the average home owner than almost any other disease that attacks his trees. This fact notwithstanding, he usually permits it to grow uncontrolled on his cedars. Annually it causes disfigurement and builds up an increasing wave of disease infection.

Until recently, the protection of apple orchards seems to have been regarded by horticultural pathologists as the chief purpose of their search for a satisfactory method of controlling the rust. Now, however, the heightened esteem of the public for the common red cedar is causing forest pathologists to focus their attention on the development of equally effective methods of protecting ornamental plantings of cedar. Home owners and the commercial tree experts who serve such owners demand control methods which will permit the growing of susceptible species of both hosts in close proximity. The experiments here described were undertaken in an effort to help solve the problem occasioned by this demand. These experiments, consisting of trial applications of several fungicides, cover a period from 1930 to 1940 inclusive.

Grateful acknowledgement is made to the Bartlett Tree Research Laboratories of Stamford, Connecticut, for supplying the site and the spray apparatus indispensable to the studies here reported.



## WHY THE RUST IS NOT CONTROLLED ON CEDAR

Upon casual consideration it might appear that the average owner of cedars is apathetic to rust injury on his own trees and even more indifferent to the countless myriads of spores released from their galls to spread infection over the property of his neighbor. That such is not always the case is clearly indicated by the increasing demands of home owners for controls that are applicable to ornamentals.

More than a hundred years have elapsed since Schweinitz (1822) gave us a description of the fungus on the cedar. A half century has passed since Halsted (1889) gave the public what was probably the first pronouncement of a real cure for the disease. He wrote "As a remedial measure it passes without further comment that it is well to destroy all specimens of the red cedar or savin." Even though in so doing we anticipate our subject, let us quote again to prove that this was truly the voice of a prophet. "The red cedar is a prominent ornamental shrub or small tree, and there would be some objection to its eradication."

Four years later Jones (1893) described as follows the results which could be obtained by eradication: "In the fall and winter of 1891-92 the red cedars were all destroyed in this orchard, and for a radius of one mile around careful examination was made, and every cedar found uprooted. The result was magical. In former years many of the apple trees were entirely defoliated by rust in August. This summer not a rusted leaf was found in the entire orchard."

During the past quarter of a century many of our most outstanding pathologists have been insistent on the eradication of cedar as the best and cheapest means of protecting orchards. Six states have cedar eradication laws. Several other states have plant pest laws under which such eradication can be undertaken.

In spite of these laws and in spite of the evident wisdom of protecting orchards by cedar extermination the cedars continue to grow and thrive. The laws have not been enforced in many of the communities which have enacted them. Nor has the general public been sympathetic toward control effected by such measures. For the orchardist the law offers a protection which has not been economically obtained with fungicides; but for the owner who prizes his cedars as well as his apples the law causes hardships.

There are more red cedars growing in New England today than there were fifty years ago when Halsted pronounced what might well have been their death sentence. In Halsted's day many farmers removed these trees from fields to give more grazing space. Now grazing is less important in some sections, and numerous farms on land which is better suited to forestry than to farming have been abandoned. In many localities neglected pastures and open fields soon tend to fairly bristle with red cedars. Ecologically these trees play an important part in the early stages of the transformation from open fields to forest. They thrive on many sites until suppressed by more shade-resistant species. In such cases control of the rust by the removal of neglected apple trees is helpful.

Cedar trees have also been extensively planted by many who consider them as among our finest ornamentals. They are especially prized as accent plants, for allées, for framing vistas and for background planting. Because of their upright habit and compact growth they are often well adapted to the plan of gardens where space is restricted. In many sections of New England there are few gardens which do not have at least one old apple tree growing in such close proximity to red cedar as to furnish ideal conditions for the development of the rust. Where there are many such gardens in a neighborhood, it is difficult to control the infection by the removal of either alternate host.

Control of the disease by sprays applied to the apple is also difficult. Spores may be wafted to these trees over a considerable period and so make necessary the repeated spraying or dusting of the rapidly developing foliage. Such treatment is highly objectionable to the average owner of an ornamental garden. Not only is the treatment costly and uncertain, but it is applied at a time when the garden is in full use and entails the use of poisonous substances objectionable in a playground. Owners are offended by the appearance of sprayed apple trees and by the spotting of the flowers and other underplanting on which the spray from such treatment frequently drifts.

That the undertaking of active measures to check this scourge has so long been delayed may be partly due to the nature of the disease itself. We are dealing with a native American rust and not with an introduced parasite. This time we have not the incen-

tive of repelling a foreign invader. Nor is zest lent to the work by any intimation that we are combatting a killer. The marvel of perfectly balanced parasitism, exhibited by certain of the rusts, is here illustrated to a nicety. Neither host is sufficiently injured to be killed. This is no improvident fungus which wipes out a tree species by a wave of infection, and in so doing ultimately causes its own decline. It is a subtle parasite which is here to stay and which will continue to collect toll either as an annual levy on our plantings or in expenditures for its control. Many owners who value their cedars are unwilling to cut them down, but are willing to defray the cost of protective treatment.

### WHAT HOSTS ARE AFFECTED BY THE DISEASE

To grow both cedars and apples in close proximity and yet have them free of rust is possible for all who are willing to make concessions as to what particular species and varieties are grown. Detailed information regarding the relative susceptibility of different varieties may be found in the writings of several authors of recognized ability. The work of Crowell (1934) will be found very helpful. The views of Niederhauser and Whetzel (1940) should not be overlooked. The report by Berg (1940) of a rust-resistant red cedar is of especial interest to all who wish to grow our native red cedar in infected areas. The species attacked can be tersely quoted from Arthur's Manual of the Rusts (1934). For the fungus *Gymnosporangium juniperi-virginianae* Schw. this last author lists the following pomaceous hosts:

*Malus angustifolia* (Ait.) Michx., *M. baccata* (L.) Desf., *M. coronaria* (L.) Mill., *M. fragans* Rehder, *M. glaucescens* Rehder, *M. ioensis* (Wood) Britt., and *M. sylvestris* (L.) Mill. On pomaceous hosts the attack is confined largely to the leaves, with less frequent occurrence on the fruit.

Arthur lists the occurrence of the fungus on *Juniperus barbadensis* L., *J. scopulorum* Sarg., and *J. virginiana* L. On these red cedars the fungus occurs on the leaves and young stems.

For the closely related fungus *G. globosum* Farl., which will be mentioned again in this article, Arthur lists as susceptible pomaceous hosts numerous species of *Crataegus* and *Malus*, and records the occurrence of the rust on *Pyrus communis* L. and *Sorbus*

*americana* Marsh. Three junipers are listed as susceptible: *Juniperus barbadensis* L., *J. horizontalis* Moench, and *J. virginiana* L.

## THE LIFE CYCLE OF THE CAUSAL FUNGUS

An extended discussion of the life history of the causal fungus *Gymnosporangium juniperi-virginianae* does not come within the scope of the present paper. For such an account the reader is referred to Heald (1909). Since, however, some knowledge of this history is essential to an understanding of the attempted control measures later described, the life cycle of the rust is briefly reviewed.

In early spring the cedar apples may be found scattered irregularly over the cedars. They are globular to kidney-shaped, chocolate brown and corky. They vary from minute swellings to galls two inches in diameter. Slender brown horns stud the surface at this season. Small galls may produce only one or two of these spore horns; large galls sometimes produce as many as 200, or more. As spring advances the spore horns swell during wet weather. In so doing they become jelly-like in consistency and orange in color. Spores known as "teliospores" are produced. These germinate within the jelly matrix to form secondary spores called "sporidia." The sporidia are wind borne.

If blown to the young foliage of susceptible pomaceous hosts sporidia are capable of producing infection. The disease first becomes apparent following an incubation period of from 1 to 2 weeks, when minute yellow spots appear on the upper surface of affected leaves. As the spots increase in size they become orange. Sometimes the lesions are bordered by a reddish margin. Minute pustules form in the centers of the lesions. Later these become black. Directly below these lesions, cushions are formed on the under side of the leaf. These bear minute cluster cups, or "aecia" which open when mature in a starlike manner to release "aeciospores." These spores are discharged from midsummer until fall. They too are wind borne.

If carried to susceptible cedars aeciospores are capable of causing infection. Authorities differ as to just when infection occurs. Some hold that it takes place shortly after dissemination, and others believe that the spores remain dormant until spring. No macroscopic evidence of infection on cedar is visible until a period several

weeks in advance of the production of the next annual crop of aeciospores on apple. At that time very minute galls are discern-

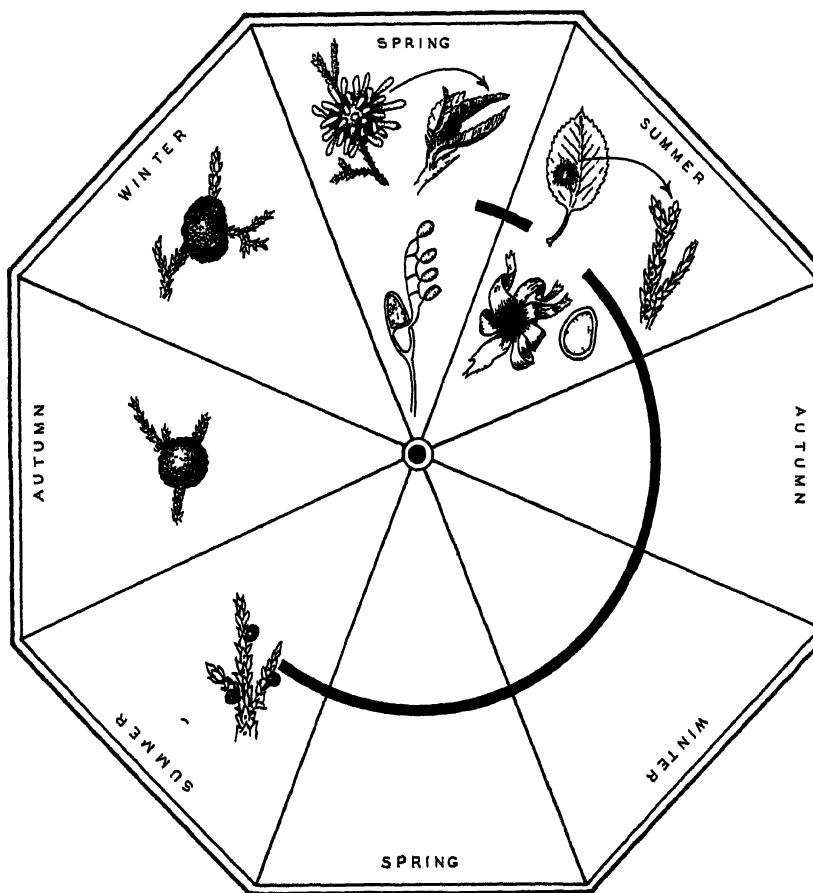


FIGURE 1. Life Cycle of *Gymnosporangium juniperi-virginianae* Schw.

Note that as indicated by the longer of the two black arcs nearly a year elapses from the time the aeciospores are first discharged from the apple until the effects of the fungus become macroscopically evident on the cedar.

ible on the leaves and young stems. During the remainder of the growing season these galls develop rapidly, reaching full size in the fall, and producing telial horns and sporidia in the second summer. (Figure 1.)

Both *Gymnosporangium juniperi-virginianae* and *G. globosum* were present in the experimental area used. As the latter rust did not cause more than a small percentage of the cedar apples in this particular area, the experiments were conducted without any attempt to differentiate, for the purpose of practical control, between these two closely related species. Galls produced by these fungi are only distinguishable with difficulty. *G. globosum* tends to fruit for several seasons while the *G. juniperi-virginianae* tends more toward fruiting for a single season. The galls produced by *G. globosum* tend to be smaller in size, more red in color, shiny rather than dull of surface, and more globose in shape. Also this species produces flatter horns than does *G. juniperi-virginianae*. These differences are, however, so poorly marked that the two species have sometimes been confused by scientific workers.

## HISTORY OF SPRAYING TO CONTROL THE RUST ON CEDAR

Few data are available on the experimental control of the rust by spraying the cedar. All chemicals and chemical compounds used in these experiments are more or less poisonous. Persons who have had no experience in handling them should not attempt such operations without skilled supervision.

Heald (1909) appears to be the first to attempt such control. He used a 6-6-48 Bordeaux\* plus 3 pounds of soap for the experimental spraying of small trees. His results showed that spraying from the period of maturity of the accia to September 1 greatly reduced the number of cedar apples and that later sprayings have little value in controlling the disease. He also stated that germination tests showed the complete failure of the teliospores to produce sporidia if the galls were sprayed with 5-6-50 Bordeaux at the time when their spore horns first became gelatinous.

Crowell (1934) advocated a 0.5% colloidal sulphur spray applied in July, August and September but stated that "no experimental data are yet available with respect to the value of spray applications on red cedars."

\*In formulae for Bordeaux sprays the first term usually refers to the number of pounds of copper sulphate, the second term to the number of pounds of calcium oxide, and the third term to the number of gallons of water.

MacLachlan and Crowell (1937) recommended 6 pounds of colloidal sulphur plus 2 pounds of sticker per 100 gallons of water to be applied in four treatments at three-week intervals, the first application being made prior to the initial discharge of aeciospores. They reported that better than 90% control was obtained by this treatment.

Strong and Rasmussen (1939) used wettable sulphur with and without sticker, but reported that sufficient time had not elapsed to determine how effective the sprays were in controlling infection.

Miller (1939) states that "theoretically an application of a fungicide to junipers during the dormant season offers protection against overwintering aeciospores and preliminary spraying experiments give promise of an effective control measure applicable to susceptible plantings of ornamental value." He further states that "Experimental evidence showed the likelihood that there are two rather distinct periods when red cedars become infected, first soon after the aeciospores are released when only a small percentage of them will germinate, and second later in the season, possibly in early spring, when infection is caused by aeciospores that have overwintered on the *Juniperus* foliage prior to their germination."

Strong and Cation (1940) used sodium dinitrocresylate (Elgetol) as a single spray applied in May to red cedars. They reported that it inhibited telial column extension and teliospore germination. A 1% solution of Elgetol Regular was found to be most effective. No injury to red cedar was apparent.

## THE EXPERIMENTAL SITE USED

The site used for the experiments here reported is located at Stamford, Connecticut. For the most part observations and treatments were made in a tract of about ten acres where eastern red cedars and various trees of the Family Malaceae occur abundantly and grow in such close proximity as to afford ideal conditions for the development of the cedar-apple rust. At the initiation of this series of experiments the disease occurred throughout the tract as an extremely heavy infection. Most of the cedars bore thousands of galls. In spring when the spore horns expanded the trees appeared to be orange rather than green. The foliage of most of

the apple hosts was yellow with rust throughout the growing season and scant because of defoliation.

Owing to its poor air drainage a one-acre plot located to the

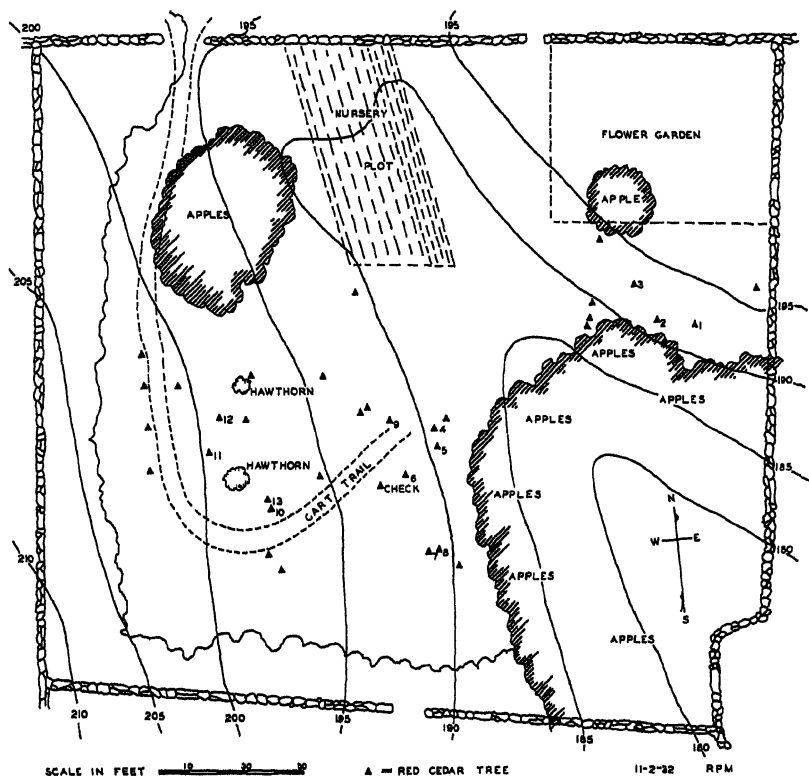


FIGURE 2. Sketch map of the one-acre plot at Stamford in which the rust infection was most severe, and where the intensive experiments were conducted.

south of the center of the experimental tract was even more subject to rust than the area as a whole. Since this particular plot was used in all the experiments recorded the reader may be interested in a more exact account of the existing conditions. A sketch map of this plot is shown as Figure 2.



This plot is bordered by trees on all sides. Immediately north of it are large shade trees and behind them a large number of red cedars and cultivated apples. To the northwest lies an eight-acre pear and apple orchard. The east, south, and west boundaries of the plot are closed in by mixed open woodland. To the south, where the trees are smaller, this woodland is largely red cedar. In the southeast corner of the plot an old abandoned apple orchard has grown into a thicket. Various ornamental apples occur both in the plot and near to it.

The contours of the terrain surrounding the site are such that it lies in a slight depression. Because of this circumstance, and also because it is almost surrounded by large trees, the site is so pocketed that it has very poor air drainage.

The location of many cedars is indicated on the map by triangles. Other cedars are present in the plot proper but have not been indicated on the map. Most of these are included in the mixed wooded border shown at the south and west sides of the map by an irregular line. A part of the 1930 tests were conducted in the mixed growth immediately south of the intensive area.

TABLE 1  
SIZE OF THE NUMBERED RED CEDARS

Number of Tree	July 21, 1932		September 19, 1934	
	Height in feet and inches	Spread in feet and inches	Height in feet and inches	Spread in feet and inches
Check .....	7'	2' 8"	7' 6"	3' 6"
1 .....	4'	1' 8"	5' 6"	3'
2 .....	2' 3"	8"	4'	1' 6"
3 .....	9' 2"	2' 6"	12'	4' 5"
4 .....	11' 8"	3' 10"	12'	5' 6"
5 .....	7' 1"	2' 2"	9'	3' 9"
6 .....	7' 6"	3'	10' 8"	4' 10"
7 .....	4' 6"	2' 6"	7' 2"	5'
8 .....	6' 8"	3' 4"	8' 8"	5' 6"
9 .....	13' 3"	3'	15' 6"	6' 8"
10 .....	7' 11"	2' 4"	10' 6"	4' 4"
11 .....	12' 6"	2'	14' 4"	3' 4"
12 .....	4' 7"	2'	7' 6"	3'
13 .....	5' 2"	1' 3"	6'	2'
Average .....	7' 5"	2' 4"	9' 4"	4'

The numbers given certain of the cedars refer to the locations of the trees which received treatment in the 1932 experiment. The size of these trees is given in Table 1. Cedars whose locations are shown but are not given numbers were used, in addition to trees adjacent to the area, as untreated checks. Of these check trees one particular tree is indicated as "Check" on the map. From this tree were made the photographs shown on Plates I and II. It also afforded an opportunity to observe and record annual variations in severity of infection. The tree became increasingly laden with galls during the period from the summer of 1932 to the spring of 1939. In the summer of 1939 it showed almost no infection, bearing only five fruiting galls in the spring of 1940. Injury incurred during the building of a fruit cellar in the fall of 1939 and further breakage in the ice storm of the spring of 1940 have unfortunately done considerable damage to this permanent check. While the damage in no way threatened the life of the tree, it was feared that the injuries might have affected the natural tide of increasing and decreasing susceptibility which this tree was selected to record. Accordingly its use was discontinued in 1940.

### TESTS OF 1930

In 1930 experiments were first conducted by the writer to test the possible value of several chemicals in controlling cedar apples on red cedar. Four blocks of ten cedar trees each were selected for treatment. Sulphur was applied as a heavy dust by means of a hand duster. Other treatments were put on as sprays, using a small, hand-operated barrel sprayer equipped with a Bordeaux nozzle. The materials used and the dates at which they were applied were as follows:

(A) *Sulphur dust.*

Dates dusted: (1) May 19, (2) May 26, (3) June 2, (4) June 11, (5) June 16, (6) June 24, (7) July 1, (8) July 7, (9) July 14, (10) July 22, (11) July 28, (12) August 7, (13) August 18.

(B) *Bordeaux mixture.*

No spreader or sticker was used. Ten pounds of ready-prepared commercial Bordeaux powder were mixed with

50 gallons of water to give an equivalent of a 5-5-50 mixture.

Dates sprayed: (1) May 21, (2) May 28, (3) June 5, (4) June 21, (5) June 25, (6) July 2, (7) July 9, (8) July 16, (9) July 24, (10) July 30, (11) August 14, (12) August 19.

(C) *Chinosol* (a yellow proprietary dye).

This material was used in a 1 to 2,000 solution.

Dates sprayed: (1) June 2, (2) June 11, (3) June 24, (-) July 1, (5) July 7, (6) July 14, (7) July 21, (8) July 28, (9) August 7, (10) August 14, (11) August 20.

(D) *Organic Mercury*.

This chemical was supplied for experimental purposes through the kindness of Dr. C. R. Orton, and was not a commercial product. It was used in a dilution of 1 to 500.

Dates sprayed: (1) June 25, (2) July 2, (3) July 9, (4) July 16, (5) July 24, (6) July 31, (7) August 14, (8) August 19.

The trees treated in these preliminary tests and the numerous untreated trees growing with them were kept under close observation during 1930 and 1931. It was assumed that in the spring of 1932, when the spore horns of the cedar apples had gelatinized, the results of the treatments would be clearly visible. It was then decided that the appearance of the young galls in late July or early August of the previous year afforded a less reliable criterion of results than did the fully developed and gelatinized galls of the spring of 1932.

This decision is based on the assumption that where there are myriads of small galls in early stages of development it is impossible that all of these galls should develop and produce spores. Reasonably accurate estimates are possible late in the growing season provided allowance be made for the non-development of overcrowded small galls.

The development of the galls is shown in Plates 1 and 2. These illustrations show that the cedar apples become fairly evident in late July, that they attain practically full size by mid-September, and that they show little development during the remainder of the year until dormancy is broken by the coming of spring.

The results of these treatments, as observed in the appearance of the cedar apples in the summer of 1931 and the spring of 1932 seem erratic and are difficult to analyze. This is not surprising since the appearance of the untreated check trees is also erratic.

In fact there was such marked lack of uniformity in the spread of infection among the trees of a block, and in the size of the cedar apples produced in a block that it was found impracticable to tabulate the results of experiment with mathematical exactness. Not only were there marked differences in the behavior of the check trees, as stated above, but an even more disturbing feature was noted. This appeared to consist of a changing susceptibility of the individual to the disease. The area under test was too uniformly subject to heavy inoculum to account for the phenomenon on a basis of disease escape. Some unsprayed check trees which had been heavily laden with cedar apples in one year were entirely free from them, or only lightly infected, the following year. In other cases the contrary was true, trees which had been free of galls during the previous season becoming heavily infected.

Giddings and Berg (1915) have recorded similar observations of their own, and to these they have added a pertinent statement by Professor H. H. Whetzel. The following quotation is from their publication:

The apparent immunity of certain cedar trees has been frequently commented upon, and various theories have been advanced to account for this condition. In sections where the rust is destructive, it is quite common to see cedar trees with few or no galls, while other trees within a few feet are actually loaded down with them. Close observation of these "immune" cedar trees has led us to believe that such immunity as they may possess is often a direct result of previous heavy infections. Infection by *Gymnosporangium Juniperi-virginianae* apparently takes place only in young growth. If the tree has been severely diseased with this rust for two or more successive seasons its growth is greatly inhibited, and the opportunity for infection would be proportionately reduced. The two-year life cycle of the fungus must be borne in mind when considering this possibility, as an infection taking place in 1913 does not become apparent until 1914.

A noticeable variation in rate and period of growth has also been observed among cedar trees which were some distance from any apple orchards. It may be that growth factors other than those resulting from rust infection have some bearing upon this matter. We do not have any exact records to prove or disprove this theory, but it is a matter worthy of careful attention.

Professor H. H. Whetzel of Cornell University advises us that he has observed a specific case of this apparent immunity in cedars. He has kindly granted us permission to use the following statement:

"During my senior year in Wabash College I made some studies of the *Gymnosporangium macropus* which occurs very abundantly on cedars and apple trees about Crawfordsville, Indiana. I observed that certain cedar trees were very badly infected, being loaded with galls, large and small, on all their twigs and branches. Other trees standing near were almost or quite free from any infection. A couple of years later I returned to Crawfordsville for a visit and went out again to see the cedar trees from which I had, during my senior year, gotten such large quantities of galls. To my astonishment they were practically free from infection, while others nearby that had borne no galls before were now badly covered with them. What the explanation of this phenomenon is, I do not know. It occurred to me, however, that a serious infection of the trees one season might have rendered them more or less immune for a time. That the infection was on different trees in these two years is certain, as I was very familiar with the different trees with which I had worked."

In estimating the results of these experimental treatments at Stamford, consideration was given principally to the number of galls produced. Some consideration was given to the size of these galls. None whatever was given to the amount of infection that had occurred on the trees in previous years. The gall crop produced by trees which had received any particular treatment was compared with the gall crop produced by the check trees and the decrease of infection expressed as a percentage.

Reduced to these terms the results of the treatments were as follows:

- (A) Sulphur dust applied 13 times gave 60% control.
- (B) Bordeaux mixture applied 12 times gave 70% control.
- (C) Yellow dye (Chinosol) applied 11 times had no apparent effect whatever on the host or on the parasite.
- (D) Organic mercury applied 8 times was helpful in checking the fungus but so injurious to the trees as to mask the results of the control effected. Such injury may have been due to the use of too high concentration.

## TESTS OF 1932

Of the treatments tried in 1930 Bordeaux mixture seemed to offer the most promise, and for that reason it was selected as the

spray to be used in the 1932 tests. Reasonably good control (70%) having been obtained by twelve applications of this material but this number of applications being too expensive for practical commercial purposes, the next logical step was to ascertain by experiment the minimum number of applications that would yield sufficiently satisfactory results with regard to both economy of cost and control of the disease. Since any improvement in the composition of the spray would presumably lessen the necessity for such frequent applications, the following changes were made in the Bordeaux mixture.

A duo type of Bordeaux powder was used in an equivalent of 4-4-50. To this, when mixed, a caseine glue sticker was added at the rate of  $\frac{1}{2}$  pound to each 50 gallons of spray. In order to carry the mixture between the scale-like leaves a spreader was also added. For this purpose 1% of spray oil was used,  $\frac{1}{2}$  gallon of oil being added to 50 gallons of mixed spray. The thirteen trees indicated on the map were treated. A barrel pump and a Bordeaux nozzle were used. The pump developed about 25 pounds pressure. Applications were made on the following schedule:

(1) The first application of spray was made on July 19, at which time the cluster cups had formed on the apple leaves but had not yet discharged spores.

(2) The second application of the spray was made on August 9.

(3) The third application was made on September 14.

Final observations, made in the spring of 1934, showed that the three applications of Bordeaux had given 60% control.

### TESTS OF 1933

The 1933 tests duplicated those of 1932 as to the trees used, the approximate schedule according to which the three applications were put on, and in the apparatus used to apply them. Ordinary commercial powdered Bordeaux was used in the place of the duo type Bordeaux. The spray was further modified by the addition of 6 pounds of dry lead arsenate. This change was made in the hope that the lead would enhance the fungicidal value of the spray and increase its sticking properties. The changed mixture now consisted of a heavy spray each 100 gallons of which contained

16 pounds of Bordeaux powder, 6 pounds of dry lead arsenate, 1 pound of caseine glue sticker, and 1 gallon of spray oil. The results given by this material were considerably better than those obtained in the previous year when the spray without the lead had been used. About 80% control was obtained.

### TESTS OF 1934

It was obvious that a three-spray schedule would be less likely to receive wide commercial use than would a single-spray treatment, provided such a treatment could be developed. Accordingly the 1934 tests were directed toward investigating the possibility of controlling the rust on the cedars by a single application.

Crowell (1934), though stating that "no experimental data are yet available with respect to the value of spray applications on red cedar," advocated the use of  $\frac{1}{2}\%$  of colloidal sulphur as a possible control for the disease. He suggested a three spray schedule which coincided in timing with the schedule followed in the 1932, 1933 trials just described.

In order to determine the relative effectiveness of this sulphur mixture and the Bordeaux mixture, tests were made with both materials. For this purpose the experimental site was divided in two. One-half of the selected plot was treated with Bordeaux, and the other half with sulphur. Dr. Crowell very kindly supervised in person the treatment of the sulphur plot. Both plots were sprayed on August 22. A commercial 4-cylinder, 200-gallon sprayer was used at 400 pounds pressure. One hundred and five cedars about 12 feet tall were sprayed with Bordeaux. One hundred and thirty cedars about 13 feet tall were sprayed with sulphur.

It was intended to use the same Bordeaux spray mixture that had been tested in the previous year. This, however, did not prove possible. Either because of some change in the commercial Bordeaux powder or in the spray oil, the mixture would not stay in suspension as it had in the previous years. Trials in test tubes showed such marked settling and precipitation that it was feared the mixture would clog the spray apparatus if used. Two brands of commercial Bordeaux powder, and three brands of spray oil were tested. In every case precipitation occurred. For this reason the oil was omitted from the formula in the 1934 tests; but this oilless mixture did not penetrate between the leaves as well as

the spray containing oil had penetrated, the previous year. The results of these tests showed that while the Bordeaux mixture was superior to the sulphur mixture, neither spray gave sufficient control to warrant reducing the spray schedule to a single treatment.

### TESTS OF 1935

Having failed to control the rust on the cedars by a single treatment applied on August 22, 1934, another trial was made of the single spray schedule by withholding application until the close of the growing season. It had at first seemed desirable to apply the spray in advance of the high peak of aeciospore development that takes place in August. This having proved inadequate, it seemed that the plan for a one-spray schedule might still be feasible if the treatment were withheld until aeciospore production had been arrested by the fall of the apple leaves. By waiting until this late period the cedars would have made final growth, and thus no new foliage would be produced to remain over winter unprotected by spray. It seemed probable too that the spray would then be very helpful in checking the germination of any aeciospores which had been carried to the tree during the growing season but had not yet caused infection. Accordingly this schedule was adopted for the 1935 tests, and both colloidal sulphur and Bordeaux mixture were used as in the previous year.

A return to the Bordeaux spray formula used in 1933 was made possible through the kindness of the late Dr. H. B. Faber of the Swann-Finch Oil Corporation who supplied a sample drum of oil which did not precipitate the Bordeaux mixture, and was compatible with the caseine glue sticker. I regret that this oil has not yet been marketed for spray purposes. It was described by Dr. Faber as "a free-flowing oil, possibly of the aromatic series, from an oil of cyclic origin." It gave better spread into the foliage and adhered better than any other oil tested. It did not have the objectionable odor of cold-pressed menhaden fish oil. Its excellent lubricating qualities appeared to reduce back pressure in the pump and friction in the nozzle.

When the results of the 1935 tests were available they did not prove sufficiently satisfactory to warrant the recommendation of single-spray treatments of either colloidal sulphur or Bordeaux mixtures applied in the fall.



## TESTS OF 1936

A single fall application was again tried in 1936. Treatments were applied as in the previous two years using the same power equipment. Three blocks of 50 cedars each were treated on October 2 with the following sprays:

(1) One-half per cent of colloidal sulphur plus 2 pounds of caseine glue sticker to 100 gallons of spray. In previous years the colloidal sulphur spray had been used without a sticker.

(2) Bordeaux spray as previously described containing a sticker, lead arsenate and oil.

(3) Two per cent solution of a copper resinate.

When the results of these applications were available all three treatments appeared to have been of some benefit. The Bordeaux was superior to the two other applications. But even with the Bordeaux the results were still not sufficiently satisfactory to justify the recommendation of a schedule which called for a single application put on in the fall in lieu of the three-spray schedule reported for 1932.

## TESTS OF 1937

In 1937, three blocks of 12 trees each were selected for experiment. A barrel sprayer, operated at 50 pounds pressure and fitted with a Vermorell nozzle, was substituted for power equipment. The same Bordeaux as in 1936 was used. The spray was applied until the trees dripped. On drying, the trees showed a very heavy bluish coating that adhered for months. A single spraying was given to each block as follows:

(1) Early spring toward the close of the dormant season.

(2) Midsummer.

(3) Autumn following the fall of apple leaves.

The results of this experimentation indicated that early spring was preferable to midsummer or fall for a single spray schedule; but because of the smaller number of trees treated these results are not regarded as conclusive.

## TESTS OF 1938

In the early spring of 1938, plans were made for the continuance of tests of the single-spray method of treatment. The addition of the sticker, the oil spreader, and the lead arsenate had improved the original formula. The question then arose: what further experimental changes in the composition of the Bordeaux mixture were advisable?

The appearance of a publication by Keitt and Palmiter (1937) on the *Potentialities of eradicant fungicides for combating apple scab and some other plant diseases* was extremely helpful at this juncture. These authors reported on the efficacy of numerous fungicidal mixtures some of which contained arsenites of calcium and zinc.

Although the arsenites of calcium and zinc are capable of causing serious injury to plant life, it is that very quality of destructiveness that renders them valuable as fungicides. Keitt and Palmiter having successfully used a spray containing these arsenites on dormant apple trees, it seemed desirable to test the same spray on cedars, the supposition being that as cedars are a hardy species they would be less likely to suffer serious injury from the spray than the apple trees.

One of the sprays, developed by Keitt and Palmiter and characterized by a high copper content and the addition of arsenites, was selected for trial. The composition of this spray may be conveniently expressed by the following formula:

*Keitt and Palmiter Bordeaux No. 180*  
*Ingredients for Each 100 Gallons of Spray*

Copper sulphate .....	12 lbs.
Quicklime .....	8 lbs.
Monocalcium arsenite .....	2 lbs.
Zinc arsenite .....	8 lbs.
Fish oil .....	7 pints
Water to make .....	100 gals.

Keitt and Palmiter give the following directions for mixing: "Use  $\frac{3}{4}$  of the required amount of water in the tank. Add the copper previously dissolved in  $\frac{1}{10}$ th the required amount of water. Add the milk of lime mixed in  $\frac{1}{10}$ th the required amount of water. Add the arsenicals made into a thin paste with water.

Add the fish oil. Add the remainder of the water. Agitate the mixture vigorously immediately after adding each material and apply promptly."

Because of its arsenite content this spray is more likely to harm people and animals, as well as plants, than is ordinary Bordeaux and should be handled with caution.

In order to minimize the risk of injury to the trees, Bordeaux No. 180 was first applied on April 14, to only three cedar trees. These trees were still dormant, and the cedar apples that they bore were unexpanded. *Forsythia intermedia* was just coming into bloom. Two of the three trees were very heavily sprayed; the third was sprayed lightly. In all subsequent spraying for 1938 and 1939 heavy coatings were applied to all trees.

Careful examination of these trees revealed no evidence of injury. On May 16, following a heavy rain, marked retardation in the gelatinization of the galls growing on the three sprayed trees was observed; the expansion of the spore horns was also retarded. These two favorable results were especially noticeable in the cases of the two trees that had received heavy coatings of spray.

On July 27, the same three cedars were sprayed again. The trees were then in active growth. The temperature at the time of spraying was 80° F. In spite of these conditions no apparent injury to the cedars resulted.

On August 10, at which time the cluster cups were well formed on neighboring apple trees, 100 gallons of the spray were applied, power equipment being used instead of the hand operated pump. On this date not only the three cedar trees previously sprayed but also 34 cedars not already sprayed during 1938 were included in the treatment. Not more than one hour after the spray had been applied a heavy rainfall began which continued through the night. Examination on the following day showed that the spray had adhered well.

The results obtained with Bordeaux No. 180 were very encouraging. The material seemed more effective in controlling the rust than the Bordeaux mixtures previously used. Only two or three galls developed on each of the three trees which had received three treatments. Some benefit was thought to have been derived from the single heavy application of spray in mid-August to trees

not previously sprayed; the accuracy of this last tentative conclusion is, however, open to question, because many of the trees which received this single treatment were included among those sprayed the following spring. It also follows that a part of the benefit interpreted later as having been derived from the spring treatment of 1939 may rightfully be attributable to the mid-August application of 1938. In no case was there any evidence of spray injury on cedar. Even the three trees which had been coated with three sprays were unharmed. As was the case with the Bordeaux previously used, Bordeaux No. 180 adhered tenaciously to the foliage. Residues from either of these Bordeaux sprays heavily applied can often be recognized in sheltered areas for about a year following their application.

### TESTS OF 1939

On April 13 Bordeaux No. 180 was again sprayed on cedars in order to determine its usefulness as a single spray when applied in early spring. The season was then almost exactly as far advanced as on the same date of the preceding year. One change only was made in the formula, viz. raw linseed oil was submitted for cold-pressed menhaden oil, the same amount of oil being used. The change was made because there had been considerable objection to the heavy odor of the fish oil which had hung for days over the trees sprayed in 1938. Three hundred gallons of spray were applied heavily to a block of cedars, a power sprayer carrying 400 pounds pressure being used. (Plate V.) An improved design of spray-gun, permitting the operator to change instantly from a fine mist to a driving spray, added greatly to the convenience and thoroughness of the treatment.

On May 3 a second block of cedars received similar treatment. Two hundred gallons of spray were applied. This was to compare the effectiveness of delayed application. At this time, however, the season had advanced but little since April 13. Almost the only noteworthy change concerned the development of the cedar apples. These now showed small spore horns.

A total of 500 gallons of spray was used for the two treatments given in 1939. The cedar trees that were sprayed varied from 5 to 30 feet in height, their average being 19 feet.

Close observation, from the time of the first spraying until the end of the year, revealed no evidence of spray injury to the cedars; but some other genera were found to be less resistant to the action of the chemicals. At the time of applying the earlier of these two sprays 100 gallons of the Bordeaux were sprayed on the wooded border of the south side of the one-acre plot. This was done in order to learn the extent of injury that might unintentionally be caused by drifting spray. The following species were present in the part of the mixed woods border that was sprayed for this purpose. *Acer rubrum* L., *Acer saccharum* Marsh., *Betula populi-folia* Ait., *Carpinus caroliniana* Walt., *Corylus americana* Marsh., *Fraxinum americana* L., *Populus alba* L., *Populus tremuloides* Michx., *Prunus pennsylvanica* L., *Quercus alba* L., *Quercus palustris* Muenchh., *Rhus copallina* L., *Rhus typhina* L.

Serious injury had occurred on *Prunus pennsylvanica*. Slight injury was observed on *Acer rubrum* and *A. saccharum*. No injury to the other tree species listed was evident. Some of the flowering plants in the underplanting, particularly violet and narcissus, were seriously disfigured.

On May 10, following a day of misty rain, the galls growing on check trees and those growing on the two blocks of sprayed trees showed the same marked differences of spore horn gelatinization and expansion that had been evident in the previous year. As a result of the application the spore horns were less expanded and their development generally retarded. This beneficial effect, however, was observed only where the galls had actually been struck by the spray. It is important to note that galls situated on parts of the trees missed by the spray, and also portions of the galls which were not entirely covered by the spray, were only slightly retarded in their development. This emphasizes the necessity of spraying very carefully and thoroughly if maximum control is to be effected.

On May 24, following rain, the differences in development of the spore horns of sprayed galls and unsprayed galls were again evident, though much less marked than they had been on May 10. In many cases sprayed spore horns which were not expanded at the time of the first inspection were now found to have expanded; but for the most part these persistent spore horns were not of normal appearance, being darker in color, and more flaccid than the horns

of unsprayed galls. (Plate III.) Germination tests in tap water showed almost no germination of teliospores from sprayed galls as against high germination of teliospores from unsprayed galls obtained from check trees.

Not only did the single spray treatment inhibit the production of teliospores by galls already present, but it was also highly beneficial in that it largely prevented the formation of new galls. Ninety per cent control of gall production seemed to have been effected by it. The results, however, are open to the same question as was raised regarding the tests of the previous year, viz. what part of this control was due to the treatment of August 1938. The amount of infection on various apple hosts growing in the vicinity was also greatly reduced. No differences were noted between the effects of the applications of April 13 and May 3; but the progress of the season, as has already been stated, was slight during this interval.

In the trials conducted in previous years a sufficient number of trees had been left unsprayed as checks on the result. In 1939 and in 1940, however, relatively few such check trees were left unsprayed within the limits of the one-acre plot. Accordingly it was necessary to check the results of spraying by reference to the condition of several hundred unsprayed cedars growing in a plot 200 yards distant.

### TESTS OF 1940

On May 17 the single spring application of Bordeaux No. 180, used in the 1939 tests was repeated. The season was now somewhat further advanced than it was at the time of the 1938 and 1939 applications. Rain during the previous afternoon and night had gelatinized the spore horns for the first time. One hundred and forty-two trees were sprayed. One hundred and twenty-six of these had been sprayed in the tests of 1939. The trees averaged 20 feet in height. Three hundred gallons of spray were applied, the spray being put on less heavily than in previous years. It will be noted that the average tree received an approximate dosage of 2 gallons of spray as against 4 gallons in 1939.

Weather conditions were highly favorable when this treatment was applied. There was a light breeze, a drying sun, and a temperature which varied from 68° to 72°. Certain other circumstances were detrimental to the value of the test. (1) The spray-

ing of the previous year had greatly reduced the number of galls. (2) The ice storm of March 3-5 had worked havoc with the trees. Considerable list and breakage had resulted, and also winter browning of the foliage was extremely severe. This latter injury was very carefully compared on treated and untreated trees to make sure that it was not a latent effect of spray injury. As the season progressed good recovery was made from the winter browning. Recovery from the breakage and list was less satisfactory. Prior to spraying several badly broken trees were removed, and in two cases replaced with new trees.

On May 24 and again on May 31 the sprayed galls which matured in the spring were carefully inspected. In spite of continued wet weather since the spray was applied on May 17 the retardation of the development of telial horns was evident.

After the lapse of a full year, it now appears that approximately 80% control was attained by the single spraying of 1940. This is highly satisfactory in view of the fact that only a moderately heavy application of spray was made in contrast with the former practice, and also because the rainfall was unusually heavy during the spring of 1940, and conditions were favorable to fungous development rather than to control.

## DISCUSSION

For two successive years a single application of a modified Bordeaux spray, applied in early spring, appears to have reduced the production of galls in the following year by approximately 80%. Exactly how this is brought about is not clearly understood by the writer. It is possible that this result is largely due to the destruction of aeciospores that have lodged on the cedars but have not yet germinated. It is uncertain whether or not the spray has any effect on the infection already established by aeciospores that have germinated. Another possibility as yet unproved is that the coating of chemicals left on the cedars may tend to check the next invasion of aeciospores blown in from neighboring apple trees. An important result of the treatment is its suppression of spore production by galls already present and the consequent protection to apple trees. The course of experiment has not been wholly free from complicating factors, and it may be that the recorded control percentages are affected by spraying during previous years. With this in mind, and in order to obtain more exact and conclusive results, further experiments are being conducted in virgin areas where no spraying has been done for many years.

Since the rust is not particularly harmful to cedars, except in severe outbreaks, it is thought that the 80% control, reported for a single application of Bordeaux No. 180, meets the requirements of the average proprietor. Where a higher degree of control is demanded for the sake of appearance, it can be obtained by additional applications of the same spray, or, if the cedars are of small size and few in number, by hand-picking galls that appear after spraying. Should the single application of spray in the spring prove as effective in other localities as it has on the site where these tests were conducted, it will keep the fungus in check without additional spraying.

Not only has no injury to the cedars been observed as a result of the spraying, but in the opinion of the majority of persons whose views have been sought, the spraying of the cedars has not caused any real disfigurement, and so should not arouse dissatisfaction such as has been frequently caused by the unsightly



appearance of heavily sprayed apple trees. It should be noted that the photograph of the sprayed cedars, shown in Plate V, D, exaggerates the change in color caused by the spray, because the bluish-gray of the dried spray is here falsely reproduced as white.

That the sprayed cedars give little or no offense to the eye may be partly due to the fact that their finely divided foliage renders the spray coat comparatively inconspicuous. It is also probable that because of the bluish tinge characteristic of the foliage of some choice horticultural varieties, the change of color, due to the dried spray, is not particularly noticeable.

It is highly desirable that the efficacy of this treatment should be tried in other localities. Spray formulae and spray schedules are not always equally effective against a parasite under the varying conditions imposed by different geographical locations. Nor is greater constancy exhibited in the degree to which the host itself may be subject to, or free from, injury as a result of such spraying.

For these reasons the treatment here described can be recommended with assurance for use in those sections only that do not markedly differ, geographically and meteorologically, from the location where the tests have been conducted. It is, however, urged that the treatment be widely used in experimental tests with a view to determining whether or not under new conditions it will be equally effective in controlling the rust and equally innocuous to the cedars sprayed.

Naturally the writer hopes that all who make such tests may find the treatment beneficial. If such should be the case, property owners and commercial tree experts will have at their command a method of control which is well adapted to their present requirements. But regardless of the success of this method, let none conclude that it, or any other similar treatment, excuses or justifies the growing of the two susceptible hosts, cedars and apple trees, side by side, on a large scale.

TABLE 2  
SUMMARY OF TREATMENTS

Year	Material Used	Number of Applications	Season Applied	Number of Trees Treated	Approximate Control Obtained
1930	Sulphur dust	13	Summer	10	60%
	Bordeaux mixture	12	Summer	10	70
	Yellow dye (Chinosol)	11	Summer	10	0
	Organic mercury (non-commercial)	8	Summer	10	Masked by spray injury
1932	Bordeaux, sticker and spreader	3	Summer	13	60%
1933	Bordeaux, lead, sticker and spreader	3	Summer	13	80%
1934	Bordeaux, lead and sticker	1	Summer	105	10%
	Colloidal sulphur	1	Summer	130	5
1935	Bordeaux, lead, sticker and spreader	1	Autumn	105	15%
	Colloidal sulphur	1	Autumn	130	10
1936	Bordeaux, lead, sticker and spreader	1	Autumn	50	12%
	Colloidal sulphur and sticker	1	Autumn	50	6
	Copper resinate	1	Autumn	50	5
1937	Bordeaux, lead, sticker and spreader	1	Spring	12	50%
	Bordeaux, lead, sticker and spreader	1	Summer	12	10
	Bordeaux, lead, sticker and spreader	1	Autumn	12	10
1938	Bordeaux, No. 180	3	Spring and Summer	3	98%
	Bordeaux, No. 180	1	Late Summer	34	Masked by 1939 spray
1939	Bordeaux, No. 180	1	Sp ing	131	90%
1940	Bordeaux, No. 180	1	Spring	142	80%

## SUMMARY

(1) There is a recognized need for a method of controlling cedar-apple rust on ornamental red cedars where the susceptible alternate hosts, cedars and apple trees, grow side by side.

(2) Several materials have been tried in an attempt to develop such a method. (See Table 2.)

(3) Bordeaux mixture to which lead arsenate and a sticker and spreader were added was found superior to Bordeaux mixture alone. A modified Bordeaux, Bordeaux No. 180, devised by Keitt and Palmiter for apple scab sanitation, was still more effective than the Bordeaux mixture containing lead arsenate and a sticker and spreader. Bordeaux No. 180 has a high copper-lime ratio and contains arsenites.

(4) Where a single annual spray is used, early spring is probably the most suitable time for application.

(5) During the past two years a single treatment with Bordeaux No. 180, applied thoroughly and heavily to cedars in early spring, has given satisfactory control of the production of new galls, great numbers of which would otherwise have appeared several months later. A single spraying has also inhibited the development of sporidia by mature galls already present. This spray has proved to be non-injurious to red cedar.

(6) These results are not given as final conclusions but are published in the hope of stimulating other workers to conduct spray tests in their several localities.

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**PLATES I - V**



## PLATE I

### The Development of the Galls

A	July 26	B	September 15
C	October 26	D	December 1
E	January 4	F	March 1

For the opposite side of this branch see Plate II



## PLATE II

### The Development of the Galls

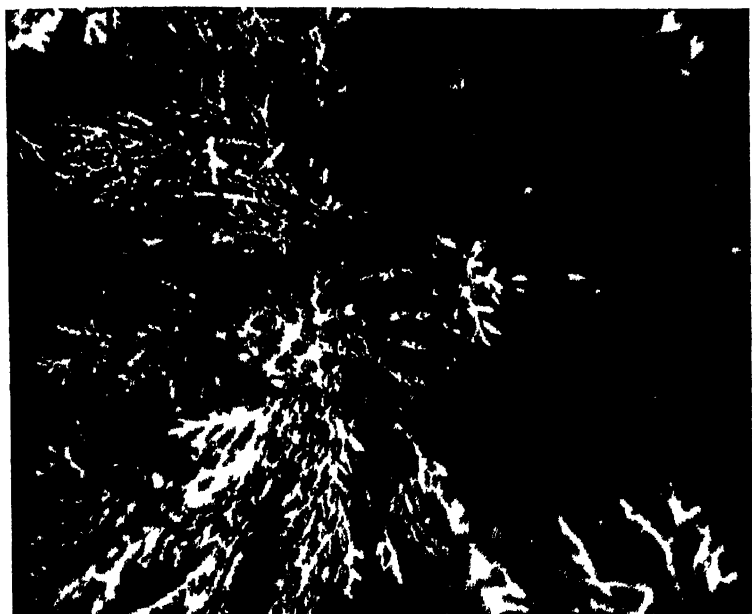
- |               |                 |
|---------------|-----------------|
| A. July 26    | B. September 15 |
| C. October 26 | D. December 1   |
| E. January 4  | F. March 1      |

This plate shows the same branch as Plate I photographed from the opposite side.



### PLATE III

The effect of Bordeaux No. 180 on the development of spore horns. Both galls were photographed on May 24, 1939. A. Unsprayed gall. B. Gall sprayed on April 13, 1939.



#### PLATE IV

Typical infection as it occurred on the experimental trees A Branch bearing young galls B Tree bearing mature galls

B



A





PLATE V

- A and B Bordeaux mixture being applied in the experimental area.
- C An unsprayed check tree
- D Appearance of sprayed trees





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A Study of Amber Spiders

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## INTRODUCTION

Knowledge of any group of animals is incomplete unless it is supplemented by evidence derived from a study of fossil representatives and extended to their earliest appearance in geological strata. The laboratory may give information concerning relationships and possible and impossible methods of evolution. The study of faunas may give a plausible outline of geographical avenues of distribution. But the element of sequence in time can be reconstructed only on the basis of paleontological evidence. It is for this reason that I turned my attention to the study of fossil spiders.

My first paper (28) was an investigation of Paleozoic Arachnida of North America. It was limited to Carboniferous fossils because no earlier material of Arachnida was available in this country. Even in Europe only Scorpions are found as far back as the Silurian. In the Carboniferous all orders of Arachnida are fully developed and in the case of spiders at least two main divisions are indicated, spiders with paraxial and spiders with diaxial chelicerae. Of the former only representatives of the Suborder *Liphistiomorphae* are known. None of the *Mygalomorphae* have been found so far. Of spiders with diaxial chelicerae three genera have been described, but we do not know even whether they possessed a cribellum or not. Neither is the number of their lungs known. I venture to suggest that *Eopholcus pedatus* Fritsch may be a Hypochilomorph spider with four lungs and a cribellum, and that *Pyritaranea tubifera* Fritsch and *Archaeometa nephilina* Pocock are cribellate spiders of the Suborder Dipneumonomorphae. But only new material may settle this question. Meanwhile it is impossible to decide how far evolution has proceeded in the Carboniferous in further subdivision of the two main branches of spiders.

The long Mesozoic Era has left us the imperfect record of a single fossil spider.

The Cenozoic Era is quite rich in fossil spiders. In this country they are chiefly found in the Florissant shale and were the subject of my second paper (29). The results of the investigation were in many respects disappointing in view of the state of preservation of the specimens. As I have pointed out in the introduction to that paper "a modern arachnologist may well condemn any attempt



at classification of extinct spiders." Nevertheless certain interesting conclusions may be drawn from that investigation. Thus there can be no doubt that Mygalomorph spiders were already in existence since they are represented in the Florissant shale by *Eodiplura cockerelli* Petrunkevitch. Whether *Segestria secessa* Scudder is properly placed in its genus remains uncertain. As stated by me "the generic affiliation of the species is . . . entirely based on external similarity with recent representatives of the genus *Segestria*." No cribellate spiders of any kind were discovered. But several families of Dipneumonomorph spiders were well represented. It was also shown that all structural characters with which we are familiar in recent spiders were already present in these fossils.

In Europe the chief source of information concerning Cenozoic spiders is contained in the Baltic amber fossils. They have been studied and described by Koch and Berendt (21) in their celebrated monograph. Koch was a great arachnologist and possessed unusually wide knowledge of recent spiders from all continents. His observations and deductions were, therefore, of great importance. Unfortunately arachnology itself was still in its infancy. The concept of the Genus was very different from what it is at present. While Koch himself established many genera which are recognized in the modern system, most of his genera had to be emended and split up into several new genera. How great is the distance traversed by arachnology since Koch's time, may be gathered from the following example. In giving a definition of the Family *Eriodontidae* Koch states in a note on page 70: "Wir zählen nun mit dieser vorweltlichen, zwei Gattungen der gegenwärtigen Familie, welche mit *Eriodon* Latr. oder *Missulena* Walck. in genauer Verwandschaft stehen und mit dieser die Familie ausmachen. Die zweite Gattung ist *Selenops* Perty." Koch's Family *Eriodontidae* consisted therefore of three genera, *Sosybius*, *Eriodon* and *Selenops*. Now *Eriodon*, undoubtedly a synonym of *Missulena*, is a Mygalomorph spider of the Family *Ctenisidae*, while *Selenops* is a Dipneumonomorph spider of the Family *Selenopidae*, not in the least related to the *Ctenisidae*. As regards *Sosybius*, a definite statement without reexamination of the type specimen is not safe. But it is certainly not a Mygalomorph spider, still less a Ctenizid. The disposition of its eyes, if the figure given by Koch is correct, is suggestive of *Selenops*.

Several other similar, though less conspicuous instances, may be found in Koch's monograph. Menge who edited it after Koch's death pointed them out in footnotes. Some of Koch's errors Menge attributed to his failing eyesight. But quite apart from the strides made by arachnology since Koch's time in respect to classification of spiders, Koch's monograph suffers from another and much more serious defect. It is the lack of exact, detailed descriptions of species, coupled with a vague definition of genera. The figures, too, are quite inadequate. They are too much alike, representing the artist's conception of the appearance of each spider when alive. And just as no measurements are given in the text, no true proportions are reproduced in the drawings. These record the general impression produced on the artist by the examination of the specimen. Such procedure would be misleading even in the case of recent spiders. The relative proportions can be grasped only after careful measurements, and exact measurement of fossil specimens is particularly difficult and tedious. Again, the chief specific characters are furnished by the structure of the male palp and of the female epigynum. These structures are present only in mature individuals. Immature specimens are extremely difficult, if at all possible, to identify. But Koch does not figure the details of these structures and does not describe them. The result is that not more than a dozen species described and figured in Koch's monograph can be identified unless, indeed, one has access to his type specimens for comparison. Menge complains in various footnotes of serious errors of observation and description, which he attributes to Koch's failing eyesight. He mentions the errors and gives corrected descriptions. But even these are of little help. In fact most of Koch's species remain unidentifiable; many are invalid, being synonyms; and the generic affiliation of his species is often extremely doubtful. This has been already pointed out by Menge, who lists a number of cases. It is bad enough when species are placed under a wrong genus, but in the correct family. But matters become very serious when the family itself is incorrect. Yet, according to Menge, Koch's species of *Philodromus* (a genus of the Family *Thomisidae*) are probably *Pytonissa* (now synonymised with *Gnaphosa* of the Family *Drassodidae*); Koch's *Therea*, placed by him in the Family *Dysderidae*, is probably a *Melanophora* (now synonymised with *Zelotes* also of the Family *Drassodidae*).

From the foregoing it will be evident to any unprejudiced mind that no true conception of the Baltic amber spider fauna can be made on the basis of Koch's monograph. Such sporadic and occasional work as has been done on Cenozoic spiders by other observers after Koch's death is scarcely better. We simply have to admit that, with the exception of a few species, the spider fauna of the Baltic amber remains unknown and any conclusions highly conjectural. The truth of this statement began to dawn on me only as my present investigation proceeded. At first I selected mature, well-preserved males in clear amber, feeling confident of my ability to identify them in view of my experience of almost forty years as an arachnologist. The disappointment was acute. It was impossible to refer them to Koch's genera and equally impossible to match them with his figures. After an intensive study of 144 specimens, only six species could be identified beyond any doubt with Koch's species, and three could be assigned to other species with a moderate degree of certainty. All others had to be treated as new species. It is quite possible that careful comparison with Koch's types would reveal their identity with some of the latter. But it would be absolutely necessary for this purpose to redescribe minutely Koch's types and to make drawings of various characteristic structures.

The value of characters will be discussed in a later chapter. Some general remarks on the subject seem, however, to be in place here. Some of our modern arachnologists, in their definitions and descriptions of species are inclined to make use of characters found only in sexually mature individuals. The male palp and the female epigynum are of especial value in this respect because they make the identification of a species as certain as the "thumb-print" makes the identification of the individual man quick and convenient. But just as the thumbprint gives no information concerning other characters of the individual, so the structure of the palp and of the epigynum leaves us entirely without information concerning anything but the identity of the species in its sexually mature stage. Yet a species must never be thought of as a stationary stage. The individual, in its transformation from egg to maturity, harbours in it at any moment of its existence characters which separate it from other species. Nothing but our ignorance prevents us from recognizing these characters. The more we disregard them, the less we can hope of ever acquiring that knowledge.

From the few existing comprehensive studies of every instar of a species we may assert that a species may be recognized in any stage of its life. But it requires careful attention to all visible characters and equally careful measurements. Reliance on a single character is of no use here. Chance coincidences are gradually eliminated as the number of coincidences grows and the possibility of error decreases until probability becomes certainty.

There are two methods of describing species. One was practiced by Simon, Frederick P. Cambridge and others, and is still followed by many arachnologists. It is the simpler and quicker method of the two and depends on the assumption that all generic characters are present in every individual. Therefore, only such characters are mentioned in the description of the species as are necessary for its separation from other species of the same genus. When a single character suffices for the purpose, no other characters are mentioned. But the assumption that a species possesses *all* the characters of the genus is gratuitous and often erroneous. There are few genera in which some of the species do not deviate to some extent from the genotype in their generic characters. Any arachnologist of much experience knows this. It is due to such discrepancies that the placing of a species in the proper genus is so often difficult and subject to personal interpretation. At the same time it is very easy to overlook the presence or absence of a *generic* character when a specimen *looks* like some known species and when the interest of the investigator is restricted to mere points of difference between allied species. Such errors resulting from gratuitous assumptions have been occasionally committed by really great arachnologists, among others by Count Keyserling who was one of the most scrupulous observers and whose descriptions were usually detailed. I have in mind the case of *Acanthoctenus spinigerus* Keyserling, the genotype of which now is regarded as the type of the Family *Acanthoctenidae*. When Keyserling published the description of the species and established the new Genus *Acanthoctenus*, he was misled by the extraordinary resemblance of this spider to known species of the Genus *Ctenus* with which he was quite familiar. Believing that his new species belonged to the Family *Ctenidae* which is easily recognized by the disposition of the eyes and the possession of only two claws on the tarsi, Keyserling overlooked the presence of the cribellum in front of the spinnerets and of the calamistrum on the fourth metatarsi,

characters with which he was perfectly familiar from his knowledge of cribellated spiders. He overlooked these characters because no cribellated spiders resembling *Ctenus* were known at the time. Keyserling described in that paper a second species, *Acanthoctenus spinipes*, but again overlooked the cribellum and calamistrum. They are not mentioned in his description of the two species and naturally are not incorporated in his definition of the Genus *Acanthoctenus* which he placed in the Family *Ctenidae*. Fourteen years later Thorell, misled by Keyserling's definition, referred to Keyserling's Genus *Acanthoctenus* three new species none of which had a cribellum, but possessed the other characters by which *Acanthoctenus* was originally separated from *Ctenus*. Only in 1892 did Simon discover Keyserling's error and correct also Thorell's mistake resulting from it. Yet both the cribellum and calamistrum are plainly visible in *Acanthoctenus* and no other explanation of Keyserling's failure to detect them is possible than that he did not look for these characters.

A similar mistake has been made much more recently in the work of an American arachnologist. Had he described the species in all detail the error could not have occurred. As regards the placing of a species in a wrong genus, this is a matter not only of common occurrence, but of much confusion as well. It is one of the causes of such extensive synonymy in many species. A wrong generic affiliation of a species may be corrected if the description is adequate, but would remain a source of irreparable error, unless and until the type were reexamined. For this reason alone the method of description referred to above should be condemned forever as scientifically unsound.

It is impossible to say who was the first to apply more detailed description of species in the case of spiders. As our knowledge of specific characters grew, the attempts at more comprehensive descriptions increased. Some of Thorell's and Keyserling's descriptions are as near perfect in this regard as the knowledge of their time permitted. I myself have always advocated the method of detailed description as the only one scientifically sound and of value in any study of comparative morphology. As practiced at present by me and some of my followers, this method consists in careful, detailed description of every external character whether of specific, generic or even higher order of value. It necessitates careful measurements some of which are given directly in

millimeters and some in ratios. Wherever possible the descriptions are supplemented by line drawings which make visualizing easier. A scientifically sound terminology, especially needed in the notation of spines on legs and of teeth on chelicerae, was proposed by me, many years ago, a terminology which makes confusion impossible and permits at the same time comparison between different species. This terminology and method of notation will be described in another chapter for the benefit of paleontologists who would otherwise have difficulty in following my descriptions of the amber spiders. It is unfortunate that some younger arachnologists do not give up the older and utterly inadequate methods. Such an attitude would be impossible in any other branch of science. This is one of the reasons for the disrepute into which taxonomy has fallen and why it is sometimes referred to as a kind of pastime in which anybody endowed with patience may indulge. I do not pretend that my terminology and notation are perfect; but they are scientifically sound and adequate for comparative morphological studies of characters. Until better ones are invented, they should be followed.

Take for example the notation of spines. In a book published in 1940 Simon's method is still advocated. It represents the distribution of spines by numbers for each row. Thus ventral 3-3, means that there are three pairs of spines; ventral 2-3 that there are only two pairs and a single spine, but whether the single spine is the first, second or third one in the same row and in which row remains uncertain. Comparison with another spider is therefore out of the question and the method has only the value of an aid to identification. On the other hand in my system of notation the absence of a spine is clearly expressed and the investigator is enabled to decide at a glance which spine has disappeared. Moreover, the spination of the anterior and posterior legs can be compared without difficulty and without recourse to mental gymnastics unavoidable when such terms as *inner* and *outer* surfaces are used for the designation of two fundamentally different morphological structures determined by the longitudinal axis and the plane of symmetry.

The results of the present investigation were as startling as they were unexpected. Of the 144 specimens studied, four were found to be in such poor condition that identification was quite impossible. The 140 specimens which were sufficiently well pre-

served for detailed study were found to represent no less than 27 families, 5 of which are new; 4 new subfamilies; 62 genera, 48 of which are new; and 78 species, 69 of which are new. This is an extraordinarily high ratio. If the collection which Koch once studied with the use of such inadequate instruments and with as yet such primitive conception of the value of minute taxonomic characters should show on reexamination the same high ratio of new genera and species, it might be found that the spider fauna of the Baltic amber was as rich and as specialized as the recent European one.

## II. ACKNOWLEDGEMENTS

The present work was made possible through the courtesy of several institutions and persons. The collection of the Department of Geology of the British Museum was placed at my disposal by Mr. T. H. Withers, Assistant Keeper, who extended the time limit of the loan over several years when my health gave out and repeated attacks of severe illness interfered with the progress of the investigation. The same courtesy was extended to me by the Sedgwick Museum of Cambridge University and its Curator, Prof. Albert G. Brighton. To both these gentlemen and to the institutions which they represent I wish to express my sincerest gratitude. My thanks are also due to Prof. R. S. Bassler of the U. S. National Museum for the loan of two specimens; to Dr. Helen H. Blauvelt for the loan of several specimens collected by the late Prof. C. R. Crosby of Cornell University; to Prof. Carl O. Dunbar for the loan of specimens belonging to the Peabody Museum of Yale University; to my assistant, Miss Mary Carbone, for help in preparation of notes; to Mrs. J. G. Wright and Miss Trowbridge for help in photographing specimens; and to Dr. Grace E. Pickford for her personal intercession on my behalf with the authorities of the British Museum and of the Sedgwick Museum.



### III. MATERIAL

As stated in the introduction the material on which the present study is based has been derived from various sources. Most of the specimens belong to the British Museum. Some of these belonged once to the Museum Stantien-Becker and were accessioned and numbered by Dr. R. Klebs. Some are part of Seebohm's Bequest 1896. Some are simply labeled Samland. All these specimens were mounted on slides in a canada balsam medium in rectangular cells protected by a cover glass. Some specimens were presented to the British Museum by A. Théry. These were in small boxes, not mounted. In all cases many of the specimens were rather carelessly cut by the original owners or dealers from whom they were purchased, with the result that in many specimens parts of the body or of the legs are missing. Probably they were used as pendants or curios before their scientific value was realized. Some are in very clear amber of light color, some are in amber which has other inclusions. In most cases bubbles of air fill the inside of the spider. Other air bubbles may be seen scattered through the amber. Quite commonly flat cleavage surfaces harbour multilobed pockets of air which reflects light and makes examination possible only from certain directions. A white opaque emulsion usually covers the ventral surface of the specimen and extends sometimes over all appendages. Some specimens are surrounded by dark brown amber. All these imperfections and obstructions make study often difficult and require special methods which will be explained in the next chapter.

A few specimens belong to the Sedgwick Museum of the University of Cambridge, England. They were not mounted and one piece was quite large and contained various inclusions. Although dark brown on the surface, it proved to be quite light colored inside. It was necessary to cut off a piece of it to be able to study the spider.

Ten specimens were purchased by the late Prof. C. R. Crosby of Cornell University to which institution they now belong.

Seven specimens belong to the Peabody Museum of Yale University. One of these was given me years ago by Prof. Th. S. Painter.

Two specimens belong to the U. S. National Museum.

One specimen belongs to Prof. H. DeTerra and was returned by me to him after careful examination.

All the above material came from East Prussia and is undoubtedly Oligocene Baltic amber.

#### IV. METHODS OF STUDY

1. *Cutting and polishing.* Mounted specimens can be studied only under very unusual circumstances if the specimen happens to be in perfectly clear amber and in such a position that body and legs are more or less parallel with the surface of the slide. Even then it is not always possible to get a view of the face or of the claws in a manner permitting examination under high power. It is advisable and in the majority of cases necessary to study the specimen not mounted but immersed in oil with a proper refractive index and of a composition harmless to amber. I use for this purpose *water white oil of cedarwood*. To prepare mounted specimens for examination in cedar oil one has first to remove them from the slide by dissolving the mounting medium in xylene at a temperature of about 60° C. This requires two or three hours. Cutting of the specimen to the desired size and shape is best done with the finest jeweller's saw blade by hand, because rapid sawing is apt to chip off pieces of amber. It is advisable whenever possible to cut the amber in the shape of a rectangular block with the surfaces as close to the specimen itself as can be done safely. Of course, in many cases this is impossible and one has to be satisfied with planes running at odd angles to each other. Polishing must be done on a horizontal, rotating disc, first an emery stone, next smooth slate and finally felt with finest alumina abrasive powder. All polishing has to be done on surfaces kept wet by dripping water. The final polish must be of a high gloss. The piece is then rinsed in running water, dried and studied in oil under a binocular microscope. Occasionally there is in the amber a large air-bubble which obstructs the view. This may be removed by drilling a fine hole leading from the surface to the air-bubble in a direction which does not create new obstruction to vision. I use a No. 80 drill, the finest one can buy in this country. It has the diameter of about 0.34 mm. The drill is held in a needle holder and slowly rotated by hand under binocular dissecting microscope. When the air-bubble is reached the drill is carefully removed and the air sucked out under a microscope with the aid of a micropipette. As one sucks out the air it is replaced by the cedarwood oil. The operation is very delicate, but the result is worth the trouble.

2. *Lighting.* The problem of lighting is a very serious one in the case of amber material. Very few sources of light are sufficiently powerful to penetrate discoloured portions or a layer of white emulsion. Moreover the direction of the ray must be capable of being shifted so as to light up portions of the interior of a piece whenever needful. Consequently such a device as the so-called Nicholas lamp manufactured by the Bausch and Lomb Co. is not convenient or adequate for this purpose. I found that an incandescent 6 v. ribbon filament light with a condenser when used with an additional condensing lens in front gives satisfactory results. The beam may be made very intense and narrow, or broad and less intense, yet still sufficiently bright. Sometimes the dish with the specimen in oil is placed on a milk white plate of glass to obtain, in addition to the reflected light, transmitted light through the reflection of the beam from the white plate. Sometimes examination over a black background is preferable. Occasionally only transmitted light of great intensity is needed. In that case the beam is directed on the substage mirror and allowed to pass through a small hole in a piece of black paper placed under the dish, so as to prevent blinding one's eyes by light passing around the specimen. Similar methods of lighting have to be used in the case of the monobjective binocular microscope. It is impossible to give more detailed instructions because every specimen, and for that matter every portion of the same specimen, requires different illumination. One thing is certain: it is no use trying to see some of the structures shown in my figures with the aid of an inadequate or improperly adjusted source of illumination. Sometimes a change in the direction of the beam, amounting to no more than a single degree will bring out structures not visible otherwise.

3. *Optical equipment.* No less important is the problem of the optical equipment. Binocular instruments are greatly preferable. For low powers I use a binocular dissecting microscope with two sets of objectives and with paired oculars from  $\times 2$  to  $\times 30$  magnification. The selection of objectives for the monobjective binocular microscope is more difficult. The working distance must be as great as possible; apochromats are therefore out of the question. I use a Leitz No. 2 (equivalent focal length 24 mm. and working distance 16 mm.) and a Leitz No. 3 (equivalent focal

length 16 mm. and working distance 5.8 mm.), but other makes of the same type of lenses are available and equally satisfactory. For higher magnification, however, only a W. Watson and Sons Parachromat with a focal length of 4 mm. (1/6 in.), and a working distance 1 mm. can be used, because it is the only lens of that type on the market. All other 4 mm. objectives have a working distance which is many times smaller. The initial power of that lens is  $\times 42$  at 160 mm. extension of the tube. With a  $\times 20$  ocular it gives a magnification of  $\times 840$ . This combination naturally does not give nearly as good definition as would be the case with an apochromat of the same initial power, but it enables one to see the teeth on the claws of small spiders, the minute structure of modified hair, etc.

4. *Measurements.* All measurements have to be made under the microscope with the aid of a calibrated ocular micrometer. My experience shows that in the case of binocular microscopes it is advisable to use a matched pair of oculars one of which has a micrometer scale. It is also advisable to use two different scales of magnification, one pair of oculars with a magnification as low as practicable and the other pair with a magnification of  $\times 20$ . This latter pair is quite indispensable in measuring such things as eyes of especially small specimens. Care must be taken to have the entire object in focus because otherwise considerable errors are unavoidable. I should also like to call attention to distortion due to reflection from planes of cleavage and to such due to refraction of direct rays incident to the amber at different angles. The latter phenomenon may be easily observed by moving the substage mirror to and fro on its axis. But even if one pays attention to all these sources of error and takes care to eliminate them it is not always possible to get two identical readings on the micrometer scale if the specimen has been allowed to change its position in the interim. Occasionally one has to make a series of measurements and select those that were repeated the greatest number of times. It is evident therefore, that measurements of amber material, as given in the following descriptions, represent only an approximation. Naturally, all measurements are in millimeters or fractions thereof.

The *total length* of a spider has very little meaning and is subject to great variations because of the elasticity of the abdomen

which may be considerably distended under the pressure of eggs or shrunk under influence of starvation. It is given merely to facilitate visualizing the size of a spider before reading its detailed description. It could be altogether omitted without impairing the value of the description. All the other measurements are of non-elastic, sclerotized structures and are not subject to variation within the same instar.

The *length of the carapace* represents the distance between the anterior and posterior transverse tangent planes. When the eyes project beyond the anterior edge of the carapace proper, the measurement includes the eyes, and when the posterior margin of the carapace is emarginate in the place where it receives the petiolus, the measurement extends to the posterior margin at its greatest distance from the head.

The *width of the carapace* represents the distance between parallel lateral planes tangent to its sides. It is advisable to measure the greatest width which is usually between the second and third pairs of coxae, the width of the head in the region of the eyegroup and, if possible, the width of the face between the antero-lateral ventral projection points of the carapace.

The *height of the carapace* is the distance between the two parallel planes tangent to the ventral and dorsal surfaces.

The *width of the eyegroup* means the distance between two planes tangent to the two points of a pair of eyes which are farther apart than any other pair regardless of which pair that may be. The same measure applies to the length of the row of eyes to which that pair belongs.

The *ratio of eyes* is expressed in the number of divisions on the micrometer scale, corresponding to the diameter of each eye. The distance between the eyes, measured from periphery to periphery in the shortest direction, are also expressed in the number of divisions covering it.

The *quadrangle* formed by the four median eyes is measured in the same way as the entire eyegroup and its ratio expressed in the same manner as the ratio of the eyes. The measurements of the width and length include the eyes.

The *height of the clypeus* is measured between the edge of the carapace in the plane of symmetry and a line tangent to the lower edge of the anterior median eyes.

The *segments of the legs* are measured from articulation to

articulation. The claws are therefore not included in the measurement of the tarsus. The *width of the patella* is measured by taking the distance between the condyli. This measurement requires high power and can be made only from above.

The *Tibial Index* was introduced by me for the expression of the stoutness of the leg. It is equal to  $\frac{100 \times \text{width of patella}}{\text{length of tibia} + \text{patella}}$ .

The *leg formula* purporting to give the relative length of the legs is usually represented by the first four numbers arranged in the sequence of greatest length. For example Legs 4123 means that the fourth leg is the longest, then comes the first, then the second and finally the third. Unfortunately this formula gives no information concerning either the relative length of the legs themselves, or their length relative to that of the body. This defect is to a great extent remedied by the figures representing the length of each leg. But a formula showing the relative lengths at a glance would be very convenient. It can be expressed by the *leg index* introduced by Harriet Exline. This index is equal to  $\frac{100 \times \text{length of carapace}}{\text{length of leg}}$  and gives a correct picture of the relative

length. Unfortunately, as in the case of the tibial index, the figure obtained is in inverse ratio to the actual length. To obviate this inconvenience I propose to use the quotients of a simple division in which the dividend is the measured length of the leg and the divisor the length of the carapace. The quotient should read to the first decimal if one wishes to avoid equal figures for legs which are in reality slightly different in length. For example, the new leg formula for *Modisimus signatus* (Banks)—a spider with long legs, common in Porto Rico—reads Legs  $\frac{1}{31.3} \frac{2}{19.1} \frac{4}{19.0} \frac{3}{15.6}$ . As a second example we may give the formula for *Theridiosoma nechodomae* Petrunkevitch, a little spider from Porto Rico with the same sequence of legs as *Modisimus*, but with relatively short legs.

The formula reads: Legs  $\frac{1}{2.3} \frac{2}{2.2} \frac{4}{1.9} \frac{3}{1.3}$ .

5. *Notation of spines.* To understand my system of notation of spines, it is necessary to remember that the terms dorsal and ventral are used in reference to the original morphological position

and therefore in reference to the articulation plane of the knee joint and not to the actual position of the leg under subsequent torsion, as in crab spiders. With other words, the dorsal and ventral surfaces are morphologically always the same whether the leg is prograde or laterigrade and whether the chelicera is paraxial or diaxial. The same is true in the case of the terms prolateral and retrolateral, usually abbreviated as pro and retro. The prolateral surface is the surface which is directed toward the anterior end of the spider when the appendage is placed at right angles to the axis of the body. The retrolateral surface faces under the same circumstances the posterior end of the body. This rule applies of course to any appendage whether leg, pedipalp or chelicera, provided one considers as dorsal that surface which is determined by the articulation points of the patella or metatarsus, or by those of the fang in the case of a chelicera. The prolateral surface is under these conditions always the same and homologous whether it be the first or the fourth leg and whether the leg be prograde or laterigrade. Thus all confusion arising from the use of such relative terms as upper and lower, or inner and outer is eliminated. In some rare cases the distribution of the spines is irregular and their notation almost impossible. In most cases each of the four surfaces of a leg has no more than two rows of spines. Depending upon the number of spines in each row they are either given as so many pairs even if they are not quite in the same transverse plane, or else one spine is supposed to be lacking and the remaining one designated by small letters d,v,p, or r, to show the surface nearest to the spine. For example: ventral 2-2-2-2-2 means that there are five pairs of spines on the ventral surface; ventral 2-0-2-2-0 means that there are only three pairs and that the pairs which are lacking are the second and fifth; ventral 2-1p-2-1r-0 means that there are only three spines in each row, but that in the row which is nearest the prolateral surface the second retroventral and the fifth spines are lacking, while in the row nearest the retrolateral surface the fourth proventral and the fifth spines are lacking. If the 0 (zero) were omitted it would be impossible to compare this formula with another in which other spines have disappeared. I realize that my system of notation is not perfect, especially because we do not know the *original* distribution of spines in any genus and are, therefore, reduced to general experience. Thus in most spiders there are only three spines in a row on the tibia and two on

the metatarsus. But we know several genera in which the number is as great as 7 and 5 respectively. But unless and until the original number is discovered, my system still permits comparison, whereas other systems do not.

6. *Drawing.* All drawings, unless otherwise stated, were made under a microscope with the aid of a camera lucida. The magnifications differ and are rarely given because the purpose of such line drawings is to show the detail of structure and not the relative size. Measurements are given in the text. If one could make all drawings to the same scale, that would be really helpful. But unfortunately that is impossible for many reasons. One feature of line drawings one should bear in mind. They represent in reality projections upon a horizontal plane, and all relative values are consequently correspondingly distorted. This results in appreciable discrepancies between actual measurements and drawings. Especially noticeable are the discrepancies in the case of the eyes. The carapace is more or less convex and the lateral eyes, when viewed under the microscope are on a lower plane than the median eyes. The measurements give the true distances as explained above. The drawings on the other hand are projections upon a horizontal plane and the distances are foreshortened. Thus it may appear that there is an error either in the measurement or in the drawing. This, however, is not the case. In a sense both are correct, but the measurements give the true relationships, while the drawing gives the same measurements as modified by projection upon a horizontal plane.

7. *Photography.* To show the actual appearance of the specimens most of the spiders were photographed. The work was done with Microtessars stopped down to F.16 or even F.22 after focusing at a point about one-third the total thickness of the spider from its upper surface. This gives the greatest possible depth of focus. Usually it was necessary to enlarge two or three times in printing rather than make the negative at the required magnification because lower original magnification gives, of course, greater depth of focus. If the specimen required only a deep yellow ray-filter (A-5250) Wratten Metallographic plates were used. This is the case when the amber is perfectly transparent and light yellow in color. In the case of darker amber an orange rayfilter was neces-



sary. In many cases there is a layer of dark brown amber surrounding the specimen, or the entire piece is dark brown, or there is a more or less opaque white emulsion enveloping usually the ventral surface of the specimen. In such cases it was necessary to use Infra Red plates and an Infra Red rayfilter. The Wratten Infra Red rayfilter No. 25 is satisfactory for such work and permits focussing with the filter in place. Occasionally one is forced to use the Wratten Infra Red rayfilter No. 87 in which case focussing should be accomplished with the aid of a red rayfilter to avoid pictures which are out of focus. The Infra Red rayfilter is then slipped in place of the red one.

One of the most troublesome difficulties in photographing amber spiders is caused by imperfections of the amber itself. Proper lighting is, therefore, of the greatest importance. I use two incandescent ribbon lights with condensers as furnished by the Bausch and Lomb Co. The beam is directed from above at an angle of about 45°. The dish with the specimen is placed on a plate of transparent glass and the latter on a plate of milk white glass with a glossy surface. This reflects from below the beam of light which passes the piece of amber. Thus double illumination is obtained: reflected light from the direct beam and transmitted light from the rays reflected by the white glass. The relative intensity of the two sources of light may be regulated by the angle of incidence and the position of the condenser. In cases when a black background is desired, the milk white glass is omitted and a sheet of black velvet is placed at a distance of about three inches below the specimen.

The specimens are photographed in cedar oil and care must be taken to have them fully immersed. Often it is necessary to photograph the specimen from an angle of view different from the one which it assumes when allowed to sink to the bottom of the dish. In such cases one must support one edge of the dish on pieces of glass or cork of the proper thickness. To use cotton instead and to support the specimen with it is inadvisable for many reasons, one of which being the fact that the cotton threads appear in the photograph and are difficult to erase. On the other hand if the tilting of the dish is great the specimen slips easily along the bottom of the dish and blurs the picture. To avoid this I place a narrow strip of glass in the dish and allow the specimen to rest against it.

8. *Mounting of specimens on slides.* When all work of study, drawing, measuring and photographing is finished it is advisable to mount the specimen on a microscope slide. This requires glass rings of various diameter and height, an electric hot plate and a mounting medium. Most specimens require either a 15 mm. or an 18 mm. ring, the former 3 mm., the latter 5 mm. high. Rarely larger rings may be needed. Naturally, a round coverglass of the same diameter as the ring must be used. Thickness No. 2 is advisable. The hot plate should be capable of maintaining a temperature between 100° and 200°C. The best mounting medium is a mixture of Clarite two parts by weight with pure mineral oil one part by volume. The Clarite has a refractive index 1.544 and a melting point 145° to 150°C. It is a synthetic Hydrocarbon Resin manufactured by the Neville Company of Pittsburgh, Pa. Only a little mixture at a time should be prepared, because it polymerizes and turns dark after repeated heating. I take 10 grams of Clarite and 5 cc. of mineral oil and heat them in a small pyrex beaker on an asbestos sheet over a small gas flame, stirring from time to time with a glass rod until the resin is fully dissolved. The slide with the specimen is meanwhile kept at a temperature of 100°C. on the hot-plate. The mounting fluid is picked up with a hot, wide-mouthed pipette and poured into the glass ring. The specimen is picked up with forceps, allowed to sink to the bottom and the ring is then filled up. Care must be taken to avoid the inclusion of air-bubbles. Should air-bubbles be present it is necessary to remove them with a hot glass rod. The coverglass, too, must be kept hot. It is allowed to rest on the mounting medium and then pressed into contact with the edge of the ring under the dissecting microscope. Two hours later, when the mounting medium is completely solidified, the excess is removed with a scalpel and the slide cleaned with xylene. The refractive index of Clarite is almost identical with that of amber and specimens mounted in the above mixture become remarkably clear. A similar mixture of mineral oil with dammar or with Canada balsam may be used and was used by me before I came to use Clarite, but is not nearly as good.

## V. RELATIONSHIP OF SPIDERS TO OTHER ARACHNIDA

The spiders represent a very natural order in the Class Arachnida which I limit at present to the following thirteen orders: Scorpiones, Palpigradi, Pedipalpi, Kustarachnae, Phalangiotarbi, Solifugae, Pseudoscorpiones, Haptopoda, Anthracomarti, Opiliones, Ricinulei, Araneae and Acari. Neither the Xiphosura nor the Gigantostraca are true Arachnida although closely related to them. They possess characters which would make their inclusion in the Class Arachnida hardly reasonable. In other words even Lankester's Sub-class Euarachnida is too broadly conceived.

As delimited by me the Class Arachnida is already fully developed in the Carboniferous. Whether other orders besides the Scorpiones are represented in the Silurian we do not know for lack of fossil material. At any rate it is safe to assume that the differentiation of the Class Arachnida into orders took place at the latest in the Silurian and possibly earlier. Moreover, four of the thirteen orders of Arachnida, namely the Kustarachnae, Phalangiotarbi, Haptopoda and Anthracomarti became extinct sometime between the Carboniferous and the Tertiary, so that only nine orders remain in existence at present. All attempts at an understanding of the relationship between different orders of Arachnida are restricted, therefore, to a comparison of the anatomy and development of recent forms and of the external skeleton of fossil forms. As it happens, the extinct orders just mentioned are of no help in this respect. Their external anatomy confirms their own Arachnid nature, but throws no light whatsoever on the origin of spiders. Some investigators were led to believe that spiders had the greatest affinity to Pedipalpi the anatomy of which is fairly well known. Certain features common to both these Orders exist, as for example the reduction of the first abdominal somite to a mere petiolus. But there are also many important differences such as the structure of the heart, which is described as having nine pairs of ostia two of which are situated in the cephalothorax; the presence of four pairs of book-lungs; fenestrated testes; the structure and function of the pedipalpi etc. Other investigators tried to establish a relationship between the spiders and the Solifugae. Here again we find similarities and differences, but the differences

are still greater. The other Orders are still less promising. Of the anatomy of the Ricinulei we know practically nothing whatsoever. I have in preparation a short contribution on this subject. There seem to be certain similarities between them and the spiders, but the differences are quite considerable. Nothing remains but to acknowledge our ignorance and to postulate an independent origin of each of the thirteen Orders of Arachnida from a common Archiarachnid stock.

## VI. EVOLUTIONARY TRENDS IN SPIDERS

In considering changes which have taken place in the course of time in the anatomy of spiders we are again and most unfortunately restricted to evidence derived almost exclusively from the study of recent species. Of the internal anatomy of fossil spiders we know practically nothing and such information as we possess is derived from a comparison of external features and the assumption that their correlation with internal structures is the same as in recent species. For example the type of articulation present in the successive segments of the leg makes it certain that fossil spiders, like their recent descendants, had no extensors either in the knee or in the tibio-metatarsal joint and that extension was accomplished by the elasticity of the interarticular membrane. Similarly the structure of the mouthparts in conjunction with the presence of a thoracic groove made it certain, even before the discovery of fossil exuvia, that the fossil spiders possessed a foregut of the same structure as the recent one, that is that they had a pharynx, an oesophagus and a pumping stomach. In this manner a great deal may be also gleaned of the probable habits of fossil spiders. But all this is only from inference. There are certain very important points in the anatomy of fossil spiders which we shall never know from direct observation, as for example the number of the ostia in the heart which is never preserved in any of the fossil spiders. What is still worse, certain chitinous structures which one would expect to see in amber spiders, are poorly or not at all visible. I have in mind the respiratory system which in my opinion is of as great importance as the heart for the understanding of relationships and evolutionary trends in spiders. Even the book-lungs are usually difficult to see and the tracheal spiracles remain invisible even in such spiders as *Dysdera* which never present any difficulties in recent species. I think it is safe to assume that in such cases the internal anatomy of the amber spiders is closely similar to that of recent species. Furthermore, on the basis of this assumption we may draw conclusions as to the probable geological period when certain changes of anatomical features have taken place. But to understand all this we still have to go for evidence to recent species of spiders and not to fossil ones.

In surveying the structure, development, physiology and behavior

of spiders and in trying to draw conclusions from information gathered in this manner we have to bear in mind certain features of the problem. The *first* of these is that in the absence of evidence derived from fossil remains any series of structural modifications, however complete, taken by itself without reference to other modifications, gives no information whatsoever as to the *direction* of modification. It attains, however, the status of complete certainty when correlated with other changes. Thus we may assume as absolutely certain that the heart of spiders has undergone a reduction in the number of ostia and relegate to the realm of impossibility an increase in their number. In other words the heart of a spider with three pairs of ostia may be derived from one with four or five pairs of ostia, but not from one with only two pairs.

The *second* point to be borne in mind is that even granted the knowledge of the direction of a modification, a series of changes taken by itself gives no information whatsoever as to the *sequence in time*. Let us once more consider the heart as an example. There is no information of any kind as to the genetic behavior of the heart. We cannot say, therefore, that a heart with two pairs of ostia must have originated from a heart with three pairs and not directly from one with four or five pairs. But if that were the case, then a spider with a quadrostiate heart may have been produced at an earlier period than a sexostiate spider. There is, of course, no evidence to support this view, but until evidence to the contrary is furnished, the possibility cannot be denied off hand. Fortunately, as in the case of direction we have correlated corroborative evidence which makes the assumption of step by step reduction in the number of cardiac ostia much more probable than a sudden skipping of one or two stages.

In another sense, however, we are left, indeed, without any evidence as to the sequence in time. For many reasons it is quite certain that each step was not taken only once, giving rise to a new line of evolutionary development. If that were so we should have to admit that a number of families possessing, say, a sexostiate heart developed from a single ancestor, a quite impossible admission in view of the fact that sexostiate spiders are found among both Mygalomorph and Arachnomorph families. It could be argued that the reduction in the number of ostia happened in each of these groups just once and that convergence of further evolu-

tion is responsible for such similarities of structure as are exhibited for example by *Ctenidae* and *Acanthoectenidae*. But such logic would be clearly unsound. For it would deny the possibility of an independent, similar change in one character and postulate other independent, similar changes in many cases. But the admission of the possibility of a similar change in several cases automatically excludes the possibility of determining the sequence in time of these changes without corroborative evidence. In other words, if we have before us two cases of a similar modification, such as the reduction in the number of cardiac ostia in Mygalomorph and Arachnomorph spiders from four to three pairs, it is impossible to determine which of the two cases has precedence in time unless we have either direct evidence in the form of geological succession or indirect evidence from correlated changes the sequence of which we know. Moreover, it is quite probable that similar changes may have occurred at different periods. Yet the logical consequence of this is quite interesting, because it means that *modifications which are later in an evolutionary sense may precede in time of appearance structures which are evolutionarily older*. Suppose we have a group of spiders with four pairs of ostia in their heart, all living contemporaneously in the Eocene and subdivided into Families A, B, C, etc. Suppose further that Family A dropped a pair of cardiac ostia toward the close of the Eocene and became Family X in the Oligocene, while Family B underwent a change in some other character, such as the number of spinnerets, but retained the original number of cardiac ostia, and that these changes occurred in the Miocene producing a Family Z. Then Family Z would be geologically younger than Family X. Yet because of its more primitive structure of the heart we should be tempted to regard Family Z as the older one. And if the original Family B of the Eocene for some reasons did not leave traces of its existence during that geological period, but only in the Miocene and then in an unaltered condition, we should certainly speak of Z as the younger family. One has to bear this in mind in discussing geographical distribution as otherwise wrong conclusions are unavoidable. I emphasize this because of the scanty remains of spiders in the deposits of many geological epochs, complete lack of fossil material from other epochs and the total destruction of all internal organs. In the case of spiders, then, we are of necessity obliged to base most of our conclusions on evidence derived from the study of

recent species, as already pointed out above. To avoid all misunderstanding in the following discussion of evolutionary trends in spiders I shall carefully distinguish facts from interpretation.

A *third* consideration to be kept in mind has to do with the origin of species, genera and families. Most of the modern geneticists interpret the formation of species on the basis of mutations of small characters and their selection where such selection may take place. Such changes result at best in the formation of new species and rarely if ever, of new genera, let alone families and still higher groups. Moreover, a certain dedifferentiation or a considerable substitution of characters would have to take place before the change could be considered of generic value, as otherwise one would expect to find a number of genera with identical specific characters, something never found in nature. To be sure, certain characters are present in all genera which are closely related, but such characters are of generic, not of specific value. The trouble is that the process of speciation goes in a different direction from that of the formation of genera, families and still higher groups. To make my thought clear I will take a concrete example. The Family *Hersiliidae* contains but a single sub-family with four genera, *Hersilia*, *Hersiliola*, *Murricia* and *Tama*. These genera are separated from each other on the basis of such characters as subarticulation of metatarsi, relative length of legs, proportions of the individual segments in the spinnerets, disposition of the eyes and appearance or shape of the face. Each genus has several species. We know eight species of the Genus *Tama* belonging to the Americas. These are distinguished by the relative measurements of the eyes, of the spinnerets, of the clypeus, of the abdomen and of the legs and chelicerae; by the structure of the male palp and female epigynum. None of the species of the other genera of the Family *Hersiliidae* possess the same combination of characters. To evolve a new genus a species of *Tama* would have to undergo a change not in its specific, but in its generic characters. To evolve a new family it would have to undergo a change not in or at least not only in its generic characters, but in its familial characters, and so on. Complementary or multiple gene mutations may account for some, but not for all cases. It is very probable that something of this nature happened when the Families *Ctenidae* and *Urocteidae* were produced. We can rarely find more striking similarities than exist between the



cribellated, sexostiate *Acanthoctenidae* and the non-cribellated, sexostiate *Ctenidae*, or between the cribellated, sexostiate *Oecobiidae* and the non-cribellated, sexostiate *Urocteidae*. One can easily imagine a multiple gene mutation involving the loss of the cribellum and its glands, the correlated loss of the calamistrum and some minor accompanying changes in other characters. In the case of the *Ctenidae* and *Acanthoctenidae* the similarity is so great that, as we have seen above, it misled so keen an observer as Count Keyserling. In localities where both families occur the collector usually has difficulty in distinguishing them in the field until and unless he has learned to pay attention to certain characters which have neither generic nor familial value, but which make the recognition of the once identified species a comparatively simple matter. Both *Ctenus* and *Acanthoctenus* have the same general appearance, same disposition of the eyes, live in the same type of environment and are similar in the manner of locomotion. The disposition of the eyes is particularly characteristic and does not occur in any other two clawed spiders. The case of *Oecobius* and *Uroctea* is similar. The shape of the body and especially the structure of the anal tubercle is the same in both. They also construct a sheet web of the same type.

The problem becomes more complicated when there is no great resemblance in the characters. There is a temptation in such cases to take refuge in the assumption that intermediate stages, the so-called connecting links have disappeared or at least are so rare that they have not yet been found among fossil remains. Such an assumption is not satisfactory, being negative in character. Attempts have been made therefore, to explain the evolution of families and still larger groups on the assumption that the mutations in such cases are of a fundamentally different character from common gene mutations. Goldschmidt (15) has put forward the view that rearrangement of chromosomes may be responsible for such fundamental changes, a single viable change being sufficient in some cases. According to him these changes are responsible for *macroevolution* and are by nature combined with dedifferentiation of specific characters. If Goldschmidt's theory were substantiated by experimental evidence it would obviate the difficulties referred to above. In this case we would have to admit the existence of at least two different ways in which new genera, families or suborders may be formed. The results, too, would be different. In

the one case the newly formed family would retain most of the characters of the family from which it originated, as in *Ctenidae* referred to above. In the other case the new family would have most of the old specific characters dedifferentiated and would consequently lose resemblance to the original stock.

A *fourth* consideration to be borne in mind has to do with the type of structures which are supposed to be primitive. We may define a primitive structure as one lacking in complexity. But *the lack of complexity is no evidence that the species is primitive in the sense of early geological origin*. That assumption, only too often met with in arachnological literature, is unsound and gratuitous. We know from other evidence which cannot be doubted that simplicity of structure is often due to a loss of old characters and not to their original absence. In fact the loss of old characters is so common and universal that it has been used as an incontrovertible evidence of regressive evolution ever since Darwin's time. If then such a spider as *Dysdera* is called primitive because of the simplicity of its characters, we may regard the statement as one showing lack of understanding because *Dysdera* possesses other characters quite remote from early geological primitiveness. Thus its heart with only two pairs of ostia is of itself incontrovertible evidence of regressive evolution, while its complex tracheal system shows equally clearly progressive evolution. Perhaps if arachnologists would get accustomed to use the term "simple" in place of "primitive" the problem of natural classification would be subject to less confusion.

A *fifth* consideration is merely a logical sequence of the foregoing ones, but just as important to keep in mind when the sequence of fundamental evolutionary changes is being considered. This consideration has to do with minor progressive evolution, that is with the formation of more complex, specific characters. Such characters rarely, if ever have anything to do with fundamental changes. Their presence means simply that evolution of such characters continues in a stock which otherwise was arrested in its evolution of fundamental characters at an earlier date. This accounts for the manifest greater complexity of species which belong to an otherwise older stock. It may involve peculiar changes in the shape of the carapace or abdomen, such as the formation of lobes or thorns. It may give rise to a more complex copulatory apparatus as the male palp of *Argiopidae* or *Linyphiidae*

when compared with that of *Dysderidae* or *Caponiidae*. Incidentally it may be worth while recalling to the attention of those arachnologists who still consider the palp and the female genital system of so-called Haplogyne spiders as evidence of their "primitiveness" the fact that the species of the unquestionably geologically primitive *Liphistiidae* all possess complicated palpi.

It is safe to assume that in case of regressive evolution leading to the formation of new families dedifferentiation of copulatory organs also takes place and that their progressive evolution has not yet caught up with the corresponding evolution of the original stock. That is why the male palp of Mygalomorph spiders is simpler than the male palp of *Liphistiomorphae*, or the palp of *Dysderidae* simpler than that of *Clubionidae*.

The sixth and last consideration has to do with embryological evidence. While it is natural to expect and certain that embryological development furnishes good evidence in support of evolutionary relationship and sequence in time, it is also true that normal embryological development may be upset by mutation of genes. Embryological evidence in itself is, therefore, insufficient for the acceptance of the view that a given structure is older because it appears embryologically earlier than a corresponding structure in another spider. It is a mistake which Holm (19) made in his latest contribution to the subject. Thus he describes two types in the formation of the abdomen, one in *Pholcus* and *Segestria*, the other in such spiders as *Aranca*, *Agalena*, *Theridion*, *Lycosa* etc. Of these two types he considers the first one as the more "primitive" because it is "even more primitive than in Scorpions" ("und auch primitiver als die Skorpione" p. 61) and is found "in otherwise more primitive spiders" ("dieser Typus bei im übrigen primitiveren Spinnen angetroffen wird..." p. 59). This is delightful logic, for it postulates the primitiveness of something because that something occurs in more primitive spiders. Unfortunately for Holm there can be no doubt that *Segestria* represents regressive evolution as compared with *Pholcus*, because *Pholcus* has three pairs of cardiac ostia, while *Segestria* has only two pairs. There can be also no doubt that *Scorpions* are geologically much older *Arachnida* than *Spiders*. Consequently in this case at least embryological evidence must be regarded as either misleading or else subject to another interpretation. At this moment I am not prepared to suggest a correct interpretation of the fact observed by

Holm that *Segestria* shows 9 postabdominal segments in its development, whereas other spiders show only from 3 to 6 postabdominal segments. It is possible that the subdivision of the abdomen into a pre-abdomen and a post-abdomen is a sign of progressive evolution, in which case *Pholcus* and *Segestria* would exhibit an advance over other spiders in this respect, rather than a "primitive" condition. The total number of abdominal segments in *Pholcus* and *Segestria* remains 12, i.e. the same as in *Scorpions*. The very fact that of these 12 segments 9 form a post-abdomen in *Pholcus* and *Segestria*, while only 5 form the post-abdomen in *Scorpions* should caution us against dangerous conclusions. The oldest known Scorpion belongs to the Silurian. The oldest known spiders were found in the Carboniferous, none are known either from the Silurian or the Devonian. Moreover, even arachnologists inclined to support the idea that *Segestria* is a "primitive" spider still find more similarity between *Pholcus* and other Arachnomorph spiders than between the former and *Segestria*.

Keeping, then, in mind the above six conditions prerequisite for a clear understanding of the problems of evolution in spiders, we may now proceed with a consideration of changes found in recent spiders.

#### A. FUNDAMENTAL CHANGES

Under this caption I intend to consider only such changes as have higher than familial value. They are not necessarily of equivalent value among themselves, but further subdivision seems to me to be undesirable. Some of these changes may have been coincident in time of appearance, others may have succeeded one another. Moreover, the same organs often exhibit secondary changes after having undergone fundamental changes. Strange as it may seem, most of the fundamental changes are regressive, i. e. they lead to a simplification of structure, rudimentation or even complete disappearance of entire organs. Only a few fundamental changes show a progressive tendency toward greater complexity.

1. *Disappearance of segmentation.* This is probably the oldest evolutionary trend in spiders and is expressed by two different mechanical processes. One consists of a simple fusion of segments with a loss of only external segmentation. The result is the formation of a single tagma, such as the cephalothorax which

is composed of the same number of embryonic somites in all spiders without exception. The other process consists in a complete disappearance of somites and proceeds from the posterior end forward. The disappearance of segmentation in the abdomen of spiders represents a combination of both processes. The maximum number of abdominal segments is 12, and they all persist throughout life in the *Liphistiomorphae*. But the first segment in all spiders becomes greatly reduced in diameter and forms the pedicel. Whether the anal tubercle of *Liphistius* represents the result of a fusion of other segments following upon the 12 visible ones will remain unknown until the embryology of *Liphistius* has been carefully studied.

In all recent spiders other than *Liphistiomorphae* the external segmentation of the abdomen has more or less completely disappeared. In adult spiders only the pedicel shows a dorsal and a ventral sclerite while the abdominal wall presents a uniform appearance. Only young spiderlings show traces of abdominal segmentation in the shape of transverse dorsal lines and in very rare cases two or three tergites may be present as in *Brachybothrium*. As already stated the maximum number of embryonic abdominal somites is 12, but as few as 9 have been described by Pappenheim in *Dolomedes*, by Hamburger in *Agalena* and by Holm in *Steatoda*. This difference in the number of somites is, however, invariably due to a lack of segmentation of the posterior end of the post-abdomen. Only the anterior five somites form the abdomen and of these the first somite becomes the pedicel. The remaining somites, from four to seven in number, fuse, become rudimentary and form the anal tubercle. As a result the latter is sometimes composed of two segments, more often of a single one.

Further disappearance of abdominal segmentation is not likely. The fifth somite bears the median and posterior spinnerets. The latter are never lost. But if such a fundamental change were possible in which all spinnerets had disappeared the surviving creature could not be regarded as a spider any more.

2. *Torsion of chelicerae*. The paraxial position of chelicerae must be regarded as the original one. The fact that the *Mygalomorphae* have paraxial chelicerae while their abdomen has lost segmentation proves that the two trends are not correlated. The articulation of paraxial chelicerae is such that motion of their basal

segment up and down is no greater than their motion in and out. It is undoubtedly this condition which forces all spiders with paraxial chelicerae to rise on their hind legs when they wish to strike. A similar attitude is known in the case of *Lycosa* and *Ctenus* among spiders with diaxial chelicerae and possibly represents a survival of an ancient habit. The torsion of the chelicerae from the paraxial to a diaxial position is not always complete, *i. e.* does not extend over  $90^\circ$  in all cases. But the advantages of such torsion are quite manifest. The resulting ability to move the chelicerae more freely in and out is further enhanced by the divergent position of the basal segments as in *Tetragnatha*.

It is, of course, impossible to decide whether the loss of segmentation preceded or followed the torsion of the chelicerae or whether both changes were coincident in time. The oldest known Arachnomorph spiders from the Carboniferous are with diaxial chelicerae and non-segmented abdomen. The segmented *Arthrodictyna*, for the first time described in this paper, is probably an immature specimen showing the second and third abdominal sternites, but the dorsal wall is missing and we know nothing of its appearance. Unlike the torsion of the legs leading to laterigrade locomotion the torsion of the chelicerae had a much deeper effect on the subsequent evolution. This is a fact, not a theory, because laterigrade locomotion is restricted to three families of Arachnomorph spiders and presents different degrees of perfection, whereas the torsion of chelicerae clearly separates all Arachnomorph spiders from Liphistiomorph and Mygalomorph ones.

3. *Changes in tarsal claws.* These changes are of two types, regressive and progressive. The original number of claws is undoubtedly three. The possession of only two claws is coupled with the presence of claw-tufts which function as an adhesive pad and enable the spider to run and climb on smooth surfaces, something impossible for three clawed spiders. As a consequence their behavior is also modified in many respects. It seems to be probable that the regressive change consisting in the loss of the third claw is in some way genetically coupled with the progressive change resulting in the production of claw-tufts. Embryologically the formation of claw-tufts is a later phenomenon than the appearance of the claws. My study of the first and second instar of a Mygal-

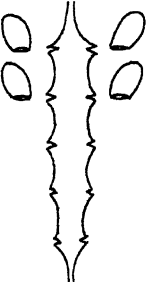
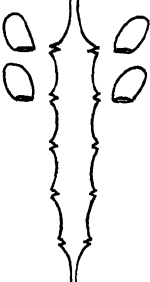
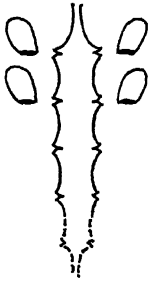
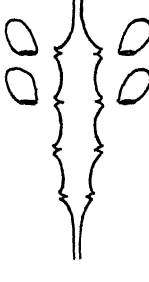


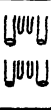

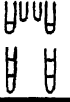
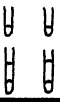
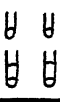
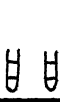




omorph spider *Phormictopus cancerides* has shown that on emergence from the egg the spiderling has "two claws without a trace of claw-tufts," whereas in the second instar "the claw-tufts are well developed." But such discrepancy in the time of appearance of genetically coupled characters is known in the case of other, experimentally studied animals. In former years I believed that the change in the number of claws had a higher than familial value, but I am not so sure of it now. Some species of the Families *Sicaridae*, *Zodariidae* and *Dyseridae* have only two claws, while the majority of species belonging to these families have three claws. In these cases the change undoubtedly came later and has only subfamilial value, unless we transfer the two-clawed species into the branch of *Dionychae* and consider them as examples of converging evolution—a procedure unlikely to appeal to any arachnologist for many good reasons. The presence of claw-tufts in the three-clawed Family *Psechridae* and the absence of claw-tufts in the Subfamily *Thomisinae* of the two-clawed Family *Thomisidae* is evidence that further independent progressive and regressive evolution of these structures is possible.

4. *Modification of spinnerets.* The origin of the spinnerets has been studied many times and Holm (19) has quite recently added new observations on the subject. Berland's statement in his otherwise excellent book *Les Arachnides* that each pair of spinnerets belongs to a separate somite from the fourth to the seventh inclusive is based either on an oversight or on a misunderstanding.

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#### TEXTFIGURE 1

A series of diagrams showing evolutionary trends in spiders of the Suborders LIPHISTIOMORPHAE and MYGALOMORPHAE, involving changes in the heart and in the spinnerets. The heart of *Anadiastothele* has never been described and it remains unknown whether it has five or four pairs of ostia. The dotted lines surrounding the spinnerets of *Liphistius desultor*, *Liphistius batuensis* and *Heptathela* show those spinnerets which lack spinning glands according to Millot. The spinning glands of *Anadiastothele* have not been studied and the spinnerets themselves are known only from a description given by Simon. Notice that the reduction of the heart proceeds from the posterior end forward, while the reduction of the spinnerets involves first those which are embryologically modified endopodites and proceeds from the anterior pair backwards and is then followed by a similar process of reduction of those spinnerets which are embryologically modified exopodites.

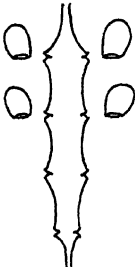
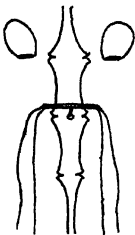
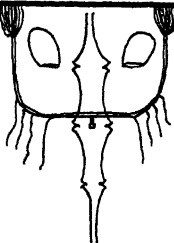
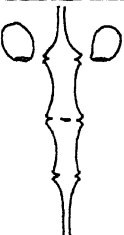
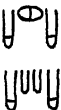
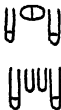
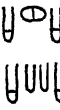
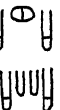
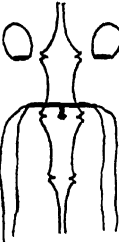
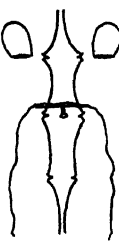
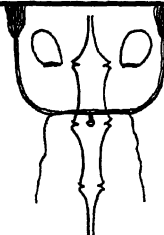
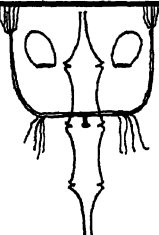
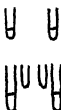
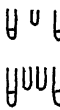

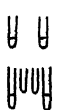
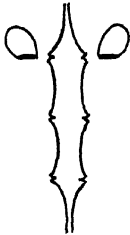
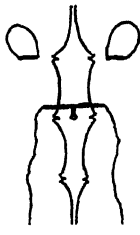
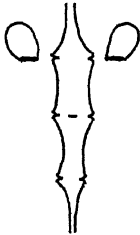
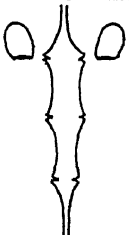
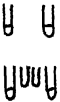


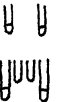
			
LIPHIST. DESULT.	LIPHIST. BATUEN.	ANADIASTOTHELE	HEPTATHELA
			
HEXATHELE	THERAPHOSA	CTENIZA	ANISASPIS
			
ATYPUS	SASON	PARAMIGAS	DIPLOTHELE
			



The spinnerets are modified abdominal appendages of the fourth and fifth abdominal somites. Like all abdominal appendages of Arthropods they are true pleopods, biramous in structure. The first abdominal somite in spiders has no rudimentary appendages at any period of its embryological development. The rudimentary appendages of the second and third abdominal somite are clearly visible in early stages, disappear completely later and in their place the organs of respiration appear. The so-called anterior spinnerets are the exopodites of the pleopods of the fourth abdominal segment. The anterior median spinnerets of *Liphistius*, the cribellum of cribellated spiders and the (anterior) colulus of noncribellated spiders are modified endopodites of the pleopods of the same fourth abdominal somite. The posterior spinnerets in all spiders are the exopodites of the pleopods of the fifth abdominal somite. The posterior median spinnerets of *Liphistius*, the posterior colulus or so-called seventh spinneret of *Heptathela* and the so-called median spinnerets of all Arachnomorph spiders are the endopodites of the pleopods of the fifth abdominal somite. This is an incontrovertible fact easily demonstrated and repeatedly figured. The endopodites in spiders are always unisegmented, the exopodites may be multisegmented as in *Liphistiomorphae*, tetra-, tri- or bi-segmented in other spiders. There is a certain law governing the changes occurring in spinnerets in all spiders. This law may be best understood from an examination of Textfigures 1, 2 and 3. It will be seen that their disappearance is a process independent of the changes in the respiratory and circulatory systems. In the *Liphistiomorphae* (Textfigure 1) the endopodites are the first to lose the spinning glands. The case of *Liphistius* is peculiar inasmuch as in one species according to Millot (7), the anterior median spin-

#### TEXTFIGURE 2

A series of diagrams showing evolutionary trends in spiders of the Suborders HYPOCHILOMORPHAE and DIPNEUMONOMORPHAE, involving changes in the circulatory and respiratory systems and in the spinnerets. The tracheal system is shown superimposed over the heart to emphasize the fact that the tracheal spiracle belongs to the same somite as the second pair of cardiac ostia. The tracheal tubes supplying the cephalothorax are shown directed forward, those supplying the abdomen are shown directed backward. Notice that in *Filistata* and *Sicarius* tracheal tubes are wanting, but the spiracle is still present, while in *Archaea* and *Pholcus* the spiracle, too, has disappeared.

			
HYPOCHILUS	PSECHRUS	DICTYNA	FILISTATA
			
			
AGALENA	THERIDION	ERIGONE	SALTICUS
			
			
ARCHAEA	PALPIMANUS	SICARIUS	PHOLCUS
			

nerets alone are lacking glands, while in another species both pairs of median spinnerets lack glands. In *Heptathela* which is undoubtedly a genus of more recent origin because these spiders lack a poison gland and have only four cardiac ostia, the posterior median spinnerets have not only lost their glands like the anterior median ones, but in addition have fused forming a non-functional posterior colulus. In *Mygalomorphae* the posterior median spinnerets are never found. They must have disappeared even before the suborder came into existence. Of the remaining six spinnerets the anterior median ones are the first to disappear to be followed by the anterior lateral ones, *i. e.* by the exopodites of the pleopods of the fourth somite. The posterior lateral spinnerets persist in all Mygalomorph spiders. The rule, then, for spiders with paraxial chelicerae is that *the posterior median spinnerets disappear first, then the anterior median and finally the anterior lateral ones.*

In Arachnomorph spiders the anterior median pair is the first to disappear. In many cases the disappearance is complete, in other cases the glands disappear, but the spinnerets fuse, forming a functionless *anterior colulus*. Bristowe (8) intent more on a criticism of my arguments than on an attempt at insight into the problem by original investigation, writes in a recent paper (p. 300): "Now the cribellum is a flat plate, and if this were to lose its function surely we ought not to expect a remnant with colulus form, *a remnant which is still more prominent in very young spiders than in adults.*" I have never thought or said that a cribellum leaves on disappearance a colulus as a remnant. We know that both the cribellum and the colulus are modified endopodites.

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### TEXTFIGURE 3

A series of diagrams showing evolutionary trends in spiders of the Branch QUADROSTLATAE, Suborder DIPNEUMONOMORPHAE, and of the Suborder APNEUMONOMORPHAE, involving changes in the circulatory and respiratory systems and in the spinnerets. The tracheal system is shown superimposed over the heart to emphasize the fact that the tracheal spiracle whether single or paired belongs to the same somite as the second pair of cardiac ostia. The tracheal tubes supplying the cephalothorax are shown directed forward, those supplying the abdomen are shown directed backward. Except for the presence of a pair of spiracles the tracheal system of *Gmogala* is not known. A comparison of this Textfigure with Textfigure 2 shows that the reduction of the heart proceeds from the posterior end forward, *i. e.* in a direction opposite to that of the reduction of spinnerets.

DYSDERA	SEGESTRIA	OONOPS	GMOGALA
ANYPHAENA	ARGYRONETA	HAHNIA	SENOCLUS
TELEMA	SYMPHYTOGNATHA	NOPS	CAPONIA

We know that both have the same origin and appearance in early embryonic stages. Surely, there is no need to expect the transformation of a cribellum into a colulus! The latest observation of Holm on *Amaurobius* shows that in the so-called second postembryonic stage the cribellum is still functionless and devoid of openings. It has the shape of a simple, low triangular protuberance (dreieckiger Zipfel) (p. 155). If development of the organ were arrested at that stage, we should have before us a colulus, as anybody with an open mind will have to admit. We have, of course, to admit the theoretical possibility that a colulus may be a remnant in my sense not of a cribellum, but of a pair of anterior median spinnerets. Unfortunately there are neither recent nor fossil Arachnomorph spiders with anterior median spinnerets. But there are plenty with a cribellum which is a modification of these spinnerets. And we have perfectly astounding similarity between cribellate and ecribellate spiders of the Families *Acanthothenidae* and *Ctenidae*, and *Oecobiidae* and *Urocteidae*. In the light of embryology and genetics the logic that postulates the transformation of these spiders is much simpler and clearer than a logic that would drag in converging evolution where that is unnecessary.

I will, however, grant Bristowe another possibility of which I have not thought before and which has escaped his attention as well. It is this. Assuming that the genetic change resulting in the transformation of the anterior endopodites into a cribellum did not affect *all* spiders and that some Arachnomorph spiders with eight spinnerets gave rise to non-cribellate spiders and themselves perished in the Mesozoic, then we would have to look for the nearest relatives of non-cribellate spiders among other non-cribellate spiders. In view of the absence of fossil remains of spiders, with a single exception, from the Mesozoic such a possibility cannot be denied, but is not likely.

For the Arachnomorph spiders we may accept then the following rule as governing the changes in their spinnerets. *The anterior median pair is the first to disappear. This is followed by the posterior median pair and finally by the anterior lateral pair.* The posterior lateral pair *i. e.* the exopodites of the pleopods of the fifth abdominal somite persists in all Arachnomorph spiders.

5. *Changes in the Nervous system.* It is unfortunate that we know so little about the nervous system of different spiders,

because it seems to be certain that it underwent fundamental changes. Millot states that in *Liphistius* all 12 abdominal neuromeres may be still recognized notwithstanding the fact that they are withdrawn into the cephalothorax. In *Hypochilus* one can see only seven abdominal neuromeres in the thoracic ganglionic mass which is, therefore, composed of a total of 12 neuromeres (not 11 as I state erroneously in a previous paper). The same number has been described in other spiders. In *Hahnia*, *Dysdera* and *Argyroneta* I am able to count only five post-thoracic neuromeres, or a total of ten. In *Symphytognatha* I am unable to see any segmentation of the ganglionic mass posterior to the neuromere of the last pair of legs, but my material was not fixed for the purpose of neurological studies and the observation needs further proof.

6. *Changes in the Circulatory system.* There is a distinct trend toward a reduction in the number of ostia in the heart of all groups of spiders. In the *Liphistiomorphae* *Liphistius* has five pairs, but *Heptathela* according to my own observation has only four pairs. In the *Mygalomorphae* four families have four pairs and four families have only three pairs of ostia. *Hypochilomorphae* have four pairs. Among the *Dipneumonomorph* spiders thirty-eight families have three pairs and ten families have two pairs of ostia. The three families of *Apneumonomorph* spiders have only two pairs of ostia. The reduction in the number of ostia proceeds always from the posterior end forward and as the heart grows shorter, the posterior abdominal artery grows longer. I have assembled the data in a previous paper (35), but have examined a number of other genera since that time and found that they fell in line with the others. Since the number of genera of spiders runs at this time almost into three thousand, exceptions may come to light eventually. They will have to be subjected to careful scrutiny. Meanwhile the existence of the trend having been firmly established it is necessary to find answers to the following two questions. Did the reduction in the number of cardiac ostia precede or follow the formation of families? Can only one pair of ostia be dropped at a time or can a sudden drop be accomplished from a higher to a lower number of ostia without intervening stages? On the answers to these questions depends our conception of natural relationship of families and their origin in the course of evolution. I have contended that the reduction in the

number of ostia preceded the formation of families and I have assumed that the reduction was stepwise. Most arachnologists objected to this view and consequently grouped families on the basis of other characters and assumed that the heart underwent a regressive change in each family independently. Thus Bristowe (8) leaves the *Pycnothelidae* as a subfamily in the Family *Paratropididae* (misspelled *Paratropodidae*) although the former, as I have shown has only three pairs of ostia, while the latter has four. He also retains in his Section A of *Mygalomorphae* the Families *Migidae* and *Barychelidae* both having only three pairs of ostia together with the *Dipluridae*, *Aviculariidae*, *Ctenizidae* (and *Actinopodidae* which he separates from the *Ctenizidae*) although all these families have four pairs of ostia.

Among the *Arachnomorphae* Bristowe recognizes the two time-worn divisions *Cribellatae* and *Ecribellatae*. In the sixth Group *Scytodoidea* of the *Ecribellatae* he puts under section B the Families *Leptonetidae* and *Telemidae*, the former of which has three pairs of ostia, while the latter has two pairs. Furthermore, Bristowe's Group VII *Clubionoidea* contains both spiders with three pairs of ostia and spiders with only two pairs. Indeed, even Section C of this Group VII is composed of several families with three pairs of ostia and two families (*Prodidomidae* and *Anyphaenidae*) with two pairs of ostia. Finally his Group VIII *Argiopoidea* consists of seven families, only one of which, *Symphytognathidae*, has two pairs of ostia, while the other six have three pairs.

Did the reduction in the number of cardiac ostia precede the formation of families or is it independent in each group or family? No direct answer can be given to this question. Even if it were proven by experiment that a mutation can occur resulting in a reduction in the number of cardiac ostia, this would only raise a further question, whether the thus produced mutation is an end-product of possible modification or the beginning of a new line of evolution leading to the formation of new families. The only answer to the above question can be obtained from a comparison of all characters and the selection of the simplest of several possible answers. I will now attempt to do this.

Assuming that one family originated by dropping one (or more) pairs of ostia we would expect to find in other respects great similarity between such a newly produced family and its parent family. In the case of the *Pycnothelidae* their closest relationship

would have to be with the *Paratropididae*. I have studied representatives of both these families. *Paratropididae* are all small, the largest being 12.75 mm. long. *Pycnothele* is large, the male type being 29 mm. long. The former resemble *Ctenizidae*, the latter *Barychelidae*. The spinnerets of *Paratropis* resemble those of *Theraphosids*, the spinnerets of *Anisaspis* and *Anisaspoides* those of *Cteniza*, while the spinnerets of *Pycnothele* are quite like those of *Barychelidae*. The tarsi of *Paratropididae* are devoid of scopulae, the tarsi of *Pycnothele* are scopulate to base, and scopulae are present on the first and second metatarsi. In *Paratropididae* the claws are with a single tooth, a rudimentary third claw may be present and claw-tufts are wanting. In *Pycnothele* only two claws are present, both pectinate in a double row and the tarsal scopulae project under and beyond the claws almost like claw-tufts, although their hairs are not of the tenent type. *Paratropididae* have only a few trichobothria, 1-1 on tarsi and metatarsi, 2 on tibiae. *Pycnothele* has numerous trichobothria, in two rows on tarsi, in a single row on metatarsi. All this shows that the *Pycnothelidae* are closer related to the *Barychelidae* than either to the *Paratropididae* or to the *Dipluridae* as originally suggested by Chamberlin (Bull. Mus. Comp. Zool. Harvard, LXI, 1917, p. 25).

Let us next consider the case of *Telemidae* placed by Bristowe in Section B with the *Leptonetidae*, while Section A of this group is formed by the *Scytodidae*, *Ochyroceratidae* and *Pholcidae*. The *Telemidae* were originally placed by Simon among the *Leptonetidae* as were also the *Ochyroceratidae*. I was the first to remove the *Telemidae* into a separate family and later into a different sub-order on account of their respiratory system and heart. There is an external resemblance between these spiders, but *Telema* is quite different from them in regard of its respiratory system. Are we to disregard this difference which is of really fundamental type merely because of external resemblance? Are we to close our eyes to the fact that often undoubtedly closely related spiders show amazing differences in appearance, and others, not in any way closely related show just as amazing similarity of appearance? The change from the respiratory type of *Scytodes* and *Leptoneta* to that of *Telema* is so tremendous that only unscientific obstinacy can deny it. But as we shall presently see, the case of the respiratory system is different from that of the heart. It is not a mere shortening of the organ with a reduction in the number of ostia. It is a complete change from one type to another.



The same argument applies to the *Symphytognathidae* whom Bristowe places in his eighth Group *Argiopoidea*. I have already elsewhere pointed out the impossibility of separating his Section B containing the *Archaeidae* from Section C containing the *Theridiidae*, *Linyphiidae*, *Tetragnathidae*, *Argiopidae* and *Mimetidae*. The *Symphytognathidae* are, indeed, clearly separable from all these, but in the structure of their respiratory system and of their heart they show much more similarity with the *Telemidae* with which, indeed, I placed them for this reason. Bristowe misrepresents the facts when he states on page 306: "Indeed, the only unique character possessed by all three families comprising Petrunkevitch's new suborder is the complete absence of lung-books." It is not the *absence* of lung-books that is characteristic, but the *presence* of tracheal tubes in their place. There is as much difference between the two cases as between losing your bicycle and having been caught riding somebody else's motorcycle. It is true that I called the new suborder *Apneumonomorphae*, but that was because I used Bertkau's term (*Apneumones*) and did not wish to coin a new term. Many a term is not as good as it should or could be, but creating new terms in their place is not always advisable.

*Symphytognatha* has many peculiarities of structure which become apparent as soon as one examines a specimen and studies serial sections. The similarities with the *Archaeidae* and *Theridiidae* which Bristowe points out are either quite trivial or else of a general type applicable to almost any spider of many families.

No better is the case of Bristowe's seventh Group *Clubionoidea*. It is, in fact, the most incongruous group imaginable. Spiders with three claws and others with two claws; with three pairs of ostia and with two pairs; with a highly developed tracheal system and with a very primitive one; with a variety of spinnerets; with aquatic, arboreal and terrestrial habits; sedentary and vagabonds; laterigrade and prograde (citigrade). By what stretch of imagination one can unite in the same group all the families listed by Bristowe is beyond understanding. I have considered in sufficient detail all these families in a previous paper (35) and have given there new information concerning some of their internal and external structures. Here I should like to mention only the *Senoculidae* which caused me a great deal of worry in the past because of the difficulty of finding any relationship between them and other spiders. More recently I have had occasion to observe

some mature females in the field and in the laboratory on Barro Colorado Island in the Canal Zone. Neither the appearance nor the behavior of *Senoculus* reminds one of *Oxyopidae*, *Lycosidae* or *Pisauridae*. Some species among the latter show some distant resemblance not sufficient for an instant to mistake one for another. The female *Senoculus* attaches its flat, grey egg-cocoon to the surface of a dead leaf which she suspends from a twig by a single thread of silk apparently as a safeguard against small ants. The mother sits head down tightly hugging the cocoon, almost invisible on its surface notwithstanding her size. The tracheal system of *Senoculus* is of the simple, abdominal type and is, therefore different from the type found in other quadrostiate spiders of my Suborder *Dipneumonomorphae*. For this reason one might be tempted to assume an independent origin for this family. But if we did so then we still should be at a total loss to find the family to which it is nearest related and from which it may have originated. Bristowe and others among my opponents place wide apart such closely resembling spiders as *Acanthoctenidae* and *Ctenidae*, *Oecobidae* and *Urocteidae*, and lump together in a single group spiders which have nothing in common with each other.

A heart with a reduced number of ostia is found in spiders of several different groups. That confirms a certain independence of the heart from other changes. It also proves as I have stated before (35) that "the reduction in the number of ostia is a more recent character than either the modification of the chelicerae from the paraxial to the diaxial type, or the change of the respiratory system." The similarities in the latter as well as in other characters make it almost certain that the reduction in the number of cardiac ostia preceded the splitting up into families.

The second question as to whether only one pair of ostia can be dropped at a time is an academic one for the present. In the case of *Heptathela* among the *Liphistiomorphae* only one pair of ostia was dropped, because *Heptathela* has four pairs and five seems to be the maximum. The sexostiate *Mygalomorphae* are in every respect closer related to the octostiate ones than to the *Liphistiomorphae* and none are known to have five pairs of ostia among the *Mygalomorphae*. Here, too, we may assume for the present that a single pair was dropped at a time and that, therefore, the octostiate ones are the older ones. The *Hypochilomorphae* with diaxial chelicerae, two pairs of lungs and four pairs of cardiac ostia stand

by themselves. The maximum number of cardiac ostia among the *Dipneumonomorphae* is three. The quadrostiate species among them are closer related to them than either to the *Hypochilomorphae*, the *Mygalomorphae* or the *Liphistiomorphae*. Here, too, the dropping of a single pair of ostia is probable. All *Apneumonomorphae* possess only two pairs of ostia. Their relationship is not clear and there are none with a single pair.

7. *Changes in the Respiratory System.* There are several types of changes in the respiratory system. Some of these are regressive, others definitely progressive. The oldest type of organs is that found in *Liphistius* and consisting of two pairs of book-lungs. These belong to the second and third abdominal somite respectively. Two pairs of book-lungs are also found in all *Mygalomorphae* and *Hypochilomorphae*. In the *Dipneumonomorphae* the first pair of book-lungs is present, but the second pair is replaced by tracheal tubes. How the substitution came about remains a mystery. The differences of structure are too great to admit the assumption of a sudden direct change. On the other hand no spiders with a rudimentary second pair of book-lungs are known and whenever other organs of respiration than the first pair of book-lungs are wanting, this condition can be traced without difficulty to a loss of the tracheal system, *i. e.* represents a further step and not one preceding the formation of the tracheal system. Of the loss of the second pair of book-lungs we speak, then, only because other spiders which have no tracheal tubes, possess such a second pair of lungs.

Unless we assume an unknown ancestor of *Dipneumonomorphae* spiders of a different type from the oldest known fossil spiders, we must come to the conclusion that the tracheal system which extends into the cephalothorax and its appendages represents a progressive evolutionary change from a system limited to the abdomen. At least two types may be recognized with various modifications. Some are shown in the diagrams Textfigures 2 and 3. To those who object to my classification I recommend their careful examination. They are based on original study and while diagrammatic are true to nature. Only in *Gmogala* the tracheal system remains unknown. One type in which the tracheal system is limited to the abdomen is represented by the series *Psechrus*, *Agalena*, *Theridion*, *Palpimanus*, *Sicarius*, *Archaea* and *Pholcus*.

The other type in which tracheal tubes extend into the cephalothorax is represented by *Dictyna*, *Erigone* and *Salticus*. *Leptoneta* is of the same type as *Agalena*. The difference of this type from that of *Telemia* will be understood at a glance. *Theridiidae*, *Linyphiidae*, *Tetragnathidae*, *Argiopidae* and *Mimetidae* are of the same type as *Agalena* or *Theridion* (in which the inner pair of tubes disappeared). A comparison of the diagram representing these genera with that of *Symphytognatha* will clearly demonstrate the impossibility of deriving the latter from the former. *Nops* and *Caponia* are at first glance similar to *Dysdera*, *Segestria* and *Oonops*. But the presence of tracheal tubes in place of lungs in the former would still be a difficult step to explain if one were to assume the derivation of the *Caponiidae* from the *Dysderidae*.

8. *Changes in other organs* The comparative anatomy of the other systems of organs is not sufficiently known to give a clear picture of any fundamental changes if such have taken place. In the case of the coxal glands which are modified nephridia, we know that in Liphistiomorph and Mygalomorph spiders there are two outlets on each side of the body, one at the base of the first coxa, the other at the base of the third coxa, while in all other spiders only the opening at the base of the first coxa is present. The loss of the poison gland occurs only in two families, *Heptathelidae* and *Uloboridae* and is clearly of familial value. The digestive system has been studied only in a limited number of species and no conclusions can be drawn from the available data. The muscular system, too, is known in detail only in a few species. In the case of the maxillary glands my studies have shown that there exist differences of higher than familial value, but our knowledge is still insufficient for an understanding of evolutionary trends.

## B. SECONDARY CHANGES

As I have already intimated above the same organs may and usually do show secondary changes in addition to and as it were superimposed over the fundamental changes. Such changes may have familial, generic or specific value. We shall examine here only such changes as may be observed externally, because they are the only changes involved in the study of fossil spiders. However important changes in internal organs may be, we are as yet neither

sufficiently familiar with them in recent spiders, nor are any traces of internal organs left in fossil spiders, except here and there a few remnants of muscles in the legs.

#### (a) CHANGES OF FAMILIAL VALUE

All characters used for the separation of families in modern Arachnology must be regarded as evolutionary changes following upon more fundamental, superfamilial changes and preceding generic changes. Some of these changes may be restricted to single families, others may be characteristic of several families without being of sufficient importance to be considered as superfamilial. In such cases we have usually before us characters which may have appeared repeatedly at different times. In some of them there are intergrading characters confusing the picture and making classification difficult. In other cases a change seems to have happened only once and that particular character is then found in all species of the same family, but not in any other spiders.

1. *Changes involving spinnerets.* We have already discussed the disappearance of the spinning glands of the two pairs of median spinnerets in *Liphistiomorphae*. None of the *Mygalomorphae* have more than six spinnerets and in all cases the missing pair are the posterior median spinnerets Textfigure 1. The reduction in the number of spinnerets being a regressive change without substitution of the lost character by some new character, the number of spinnerets is not a fixed one for each family. The *Atrypidae* have six spinnerets, the *Theraphosidae*, *Migidae* and *Pycnothelidae* have four spinnerets. The *Ctenisidae*, *Dipluridae* have six or four spinnerets, the *Paratropididae* and *Barychelidae* have four or two spinnerets. The number 4 is the typical number for the great majority of Mygalomorph spiders.

The shape of the posterior spinnerets has familial value in *Dipluridae*. In this family they are very long, thin and flexible. The relative length of the third segment is characteristic for *Theraphosidae*, but is also found in other families in some genera. The short, rounded type of the third segment is characteristic of *Ctenisidae* and *Barychelidae*.

The change which has caused the greatest controversy among arachnologists is the transformation of the anterior median spin-

nerets into a cribellum and their loss in non-cribellated spiders. The fact that the presence of the cribellum is coupled with the presence of the so-called calamistrum on the fourth metatarsi for a long time complicated matters until modern genetics came to the rescue in other, similar cases. Presumably coupled with the genes for the cribellum and calamistrum is also the gene (or genes) for the cribellar glands which are wanting in non-cribellated spiders. These genes are not sex-linked even though in some species the mature male lacks cribellar glands, cribellum and calamistrum, while the female has them. The immature male always possesses them. Even without experiments in breeding, which are still wanting, we understand now why these characters appear and disappear together. We also know from embryology that the colulus is nothing but a rudiment of the fused embryonic tubercles which in cribellated spiders develop into a cribellum and in Mygalomorph spiders with six spinnerets into the anterior median spinnerets. At present the chief controversy revolves around the question as to the relationship between the cribellated and non-cribellated spiders. Do they form two equivalent groups or if not, what is their relationship? There may be at least three possible answers to this question. First, we may assume that the two groups are equivalent having originated from two different ancestral stocks. This point of view formed the foundation of Simon's classification and is at present accepted by many arachnologists. The chief difficulty met with in this case is presented by the extraordinary similarity of structure between at least two cribellated families and two non-cribellated ones as discussed above. Such similarity would have to be explained on the basis of converging evolution. Strictly adaptive characters, such as protective coloration or special development of the organs of defense would not present many difficulties to such an explanation. When it comes to the disposition of the eyes or the peculiar fringe of the anal tubercle, the difficulty becomes insurmountable at least in the present state of our knowledge.

Second, we may assume that one species of cribellated spiders gave rise to a non-cribellated one and that the latter served then as an ancestral stock furnishing all the non-cribellated families. Such an assumption would be confronted with the same difficulties as the first one.

Third, we may assume that non-cribellated spiders originated

at different times from different cribellated ancestors and in their turn gave rise to new non-cribellated families. The difficulties encountered by this view are not the same as in the case of the other two views. Similarities become easily understandable as characters retained after the disappearance of the cribellum. On the other hand new difficulties arise. One is lead to expect more close similarities than actually exist. Even if there existed for each group of related non-cribellated spiders a cribellate family to which they could be referred as descendants, the origin of the diverse cribellate families themselves would still beg elucidation. Moreover, and this is the most serious objection, the cribellated spiders would have to be regarded as the older group from which the younger, polyphyletic, non-cribellated spider group is derived. If we unite cribellated and non-cribellated spiders in a single group, we do so in disregard of their age, for all the former are undoubtedly potentially older than the latter. If we segregate the cribellated spiders in a separate group we lose the connection between such closely related families as *Ctenidae* and *Acanthoctenidae*, *Urocteidae* and *Oecobiidae*. But is the objection based on difference of age as serious as it appears to be at first sight? I do not think so. The process of evolution will never cease while there is life on earth. Whether changes are progressive or regressive, they are changes and every species, every genus, every family is of necessity composed of evolutionarily older and younger members. This disparity of evolutionary age is even greater in the case of the other type of classification, such as advocated by Bristowe and others. It is greater because I have at least segregated in a separate suborder spiders with two pairs of ostia and tracheal tubes in place of book-lungs, and into a separate Branch *Quadrostiata* of the Suborder *Dipneumonomorphae* spiders with two lungs, but with only two pairs of ostia, whereas Bristowe not only places them in the same suborder with others, much older Arachnomorph spiders, but goes so far as to include Apneumonomorph spiders in the same sections of the same group of the same division. Thus he places the *Telemidae* with the *Leptonetidae* in Section B of Group VI of Division II of the Suborder *Arachnomorphae*, and the *Symphytognathidae* in Section A of Group VIII of Division II. So if the objection to a disparity of evolutionary age is valid, my classification is the one least of all exposed to it. When one deals with such cases as these, it is largely a matter of

judgment how to arrange the groups in such an order that the relationship between them would be neither lost sight of, nor exaggerated, nor minimized. The appearance of the cribcilum in place of the anterior median spinnerets is unquestionably an older change than the substitution of the second pair of lungs by tracheal tubes. Most arachnologists are willing now to separate from the other cribellated spiders the *Hypochilidae*, because they have four pairs of cardiac ostia and two pairs of lungs. They are undoubtedly the oldest Arachnomorph spiders in existence. It would be more reasonable to make of them a division separate from the Division *Cribellatae*. The only objection I have to the retention of the *Cribellatae* thus restricted is the fact mentioned above, namely that the segregation of these spiders into a separate taxonomic unit makes us lose sight of the relationship between them and dipneumone spiders. If the structural relationship of the *Caponiidae* to the *Dysderidae*, of the *Telemidae* to the *Leptonetidae* and of the *Symphytognathidae* to the *Theridiidae* were as close and as clear as that between some of the cribellate and non-cribellate families, it might be argued that these three families should be left in the same groups with their relatives. Unfortunately the similarities are not great, while the differences in the respiratory system are fundamental, making their removal into a separate suborder less hazardous and more reasonable.

As regards my Branch *Quadrostiatae* of the Suborder *Dipneumonomorphae*, its retention as a separate Branch or incorporation into the other two Branches rests chiefly on the answer to the question as to how much similarity of structure they exhibit in common with other Dipneumonomorph spiders. The mere reduction of the heart from three to two pairs of ostia makes them evolutionarily younger, but does not mean that they have all the same ancestor. If great similarities existed, it would be possible, perhaps even advisable to drop the Branch *Quadrostiatae*. Simon tried to establish relationships on the basis of the external characters including also the genitalia. His attempt to separate *Haplogynae* from *Entelogyntae* I believe to be a failure, because there is no fundamental difference in the structure of the reproductive organs, merely greater or lesser complexity. I, too, have tried to find relationships, but found instead the difference in the tracheal system, which applies more or less to all Quadrostiate spiders except the *Senoculidae*. Leave out the latter and the remain-



ing *Quadrostiatae* are remarkably uniform at least in regard to their respiratory and circulatory systems. Can anything be gained by throwing together in one Group *Clubionoidea* such diversely structured families as those which Bristowe places in that group? If anything more incongruous could be assembled I should like to be shown how to do it. If the reader inclines to doubt my statement, let him arrange a parallel table of characters for all families included in Bristowe's Group *Clubionoidea* and see where the comparison leads him.

2. *Changes involving hair.* In discussing structural variations in hair one must clearly separate in one's mind all forms referable to hair from such which have nothing to do with it while outwardly resembling hair. F. P. Cambridge, as far as I know, was the first to call attention to the necessity of such separation and of a correspondingly proper use of terminology. Unfortunately this has not always been done. Fortunately, on the other hand, most structures called spines are of the modified hair type. Only few similar structures are non-articulated outgrowths incapable of being shed except in moulting. For such structures the terms *thorns* and *teeth* should be used. All hair is capable of conveying the sensation of touch, but only so-called *trichobothria* are true sensory organs of the hair type, each connected with a sensory nerve. These will be considered separately.

Structural modifications of the non-sensory, articulated hair are numerous and of diverse kind. The first and most common modification is increase in stoutness and length. Between simple hair, bristles and spines there are all possible gradations. They all have definite distribution, but only spines and occasionally, and only to a certain extent, bristles are fixed as to number. We have already discussed my method of notation of spines. Quite recently Ivy and Chamberlin tried to introduce a new method of notation. Their method would be good if it were based on comparative morphology of all families of at least the same Suborder. A single glance at their diagram representing the supposedly maximum number of spines will show that that notation is inapplicable to many spiders, such, for example as *Mimetidae* and some *Pisauridae* and *Sparassidae*. Nor could it be used in the case of many *Mygalomorphae*.

Spines being used extensively in descriptions of spiders, they

require the first attention. However, not much can be said about their familial value. The best known and most conspicuous example is furnished by the Family *Mimetidae* in which the pro-lateral spines of the first and second metatarsus and tibia are modified and arranged in a manner not found in any other family. The arrangement of serrated bristles in the shape of a *comb* on the fourth tarsus in *Theridiidae* is also usually given as a distinct character. But my own investigations have shown that the development of a comb is a relative character and that transitions from a comb of serrated bristles to a row of simple bristles are not infrequent. The calamistrum already mentioned in connection with the cribellum is an example of superfamilial arrangement of bristles on the fourth metatarsus.

Fine hair and its varieties in the shape of plumose, spatulate, squamose, etc., hair always shows a more or less regular distribution on the body and its appendages. None has strictly familial value, but all hair is of great help in the taxonomy of spiders. The angle at which the hair stands in respect to the longitudinal axis of the leg is also an important character which when used in combination with other characters may help the identification of the spider; but in itself it has no familial value.

3. *Changes involving claws.* We have seen already that the disappearance of the third claw has either superfamilial or familial value. Changes in the structure of the claws themselves while not strictly of familial value are nevertheless often so characteristic that the study of claws is always of the greatest taxonomic importance. The most remarkable change is the doubling of the originally single row of teeth. Apparently this has occurred independently in several families. It is difficult to say whether genera with claws pectinated in a double row should be always segregated in a separate subfamily. I have done so in the case of the *Diplurinae*, while in the *Ctenizinae* our knowledge of the claws of various species is insufficient to attempt separation at this time. Claws with two rows of teeth are further characteristic of the Families *Pycnothelidae* and *Oonopidae*. Among the *Sicariidae* we meet with the peculiar condition of only the retroclaw being pectinated in a double row and then only in the Subfamilies *Scytodinae* and *Periegopinae*.

Another and in this case a regressive change which is often

characteristic when taken in conjunction with other characters is the disappearance of the teeth. We find smooth claws in the Family *Homalonychidae* and in two subfamilies of *Theriduidae*.

A progressive change resulting in a dissimilarity of the two upper claws is found in many families. The dissimilarity may be of two different types. Either the two claws of the anterior tarsi are similar, but different from the two claws of the posterior tarsi; or the proclaw on all tarsi is similar, but different from the retro-claw. The difference may have subfamilial value, but usually presents gradations within the same subfamily

The presence of the so-called *onychium* at the end of the tarsus, bearing the claws, is a character which has been interpreted as a primitive one. This is certainly wrong. Neither the *Liphistiomorphae*, nor the *Mygalomorphae* show any tendency for the formation of an onychium, while among Arachnomorph spiders it is specially developed in such forms as the *Oonopidae* which possess only two pairs of cardiac ostia and a highly developed tracheal system. It is a progressive trend which we cannot fully appreciate because we do not know the function of the onychium.

The so-called *spurious claws* are morphologically nothing but modified hair. They are serrated bristles grown stout and supplied with strong, but rather few serrations. They have familial value, but owing to their origin they often present gradations from typical spurious claws to serrated bristles of the kind found elsewhere on the tarsus.

4. *Changes involving trichobothria.* Trichobothria are sensory hairs the function of which is not yet fully understood. Their distribution is limited to the tibia, metatarsus and tarsus of the legs and tibia and terminal joint of the palp. Occasionally they are found on the femur as in the Subfamily *Tetragnathinae*. Their arrangement in one or two rows has usually familial value. In some families as in the *Agelenidae* their appearance is typical on the tarsi in that they increase in length distally. When the number of trichobothria is reduced to a single one, its position in front or behind the middle of the metatarsus or tarsus may also have a subfamilial value. This was already recognized by Dahl and Kulczynsky. It is unfortunate that some modern arachnologists persistently refuse to pay attention to the number, distribution and arrangement of the trichobothria. Like the majority of

characters trichobothria are subject to variation, and if used in conjunction with other characters become valuable.

5. *Changes in the disposition and number of eyes.* The maximum number of eyes in spiders is eight, but there may be six, four two or none. In the majority of cases the reduction in number is of only generic value, but in other cases has subfamilial, or even familial value. We know now that the reduction may involve more than one pair of eyes at a time and that it is therefore improper to establish evolutionary series.

The disposition of the eyegroup is always an important character. In some families it is of familial value, as in *Salticidae*, *Selenopidae*, *Pholcidae*, *Sicariidae*, *Lycosidae*, etc. As I have shown many years ago the eyegroup changes slightly, but quite perceptibly from the first to the last instar, so that the general pattern remains, but the relative measurements are different for each instar. It is also only the general pattern that has familial value. Changes within the pattern have usually only generic value. Certain trends are noticeable. For example in *Salticidae* the eyes of the second row move closer either to the eyes of the first row or to those of the third row. Most of such changes have a correlation with the field of vision. Some changes in the size of the eye have also a correlation with the acuity of vision. However, notwithstanding my own studies and those of Scheuring (Zool. Jahrb., Anat., 1913, 1914) and especially of Hohmann (Zeitschr. vergl. Physiol. 1928, 1931, 1934), knowledge is still inadequate for the establishment of real evolutionary trends. We may however, point out that in *Salticidae* by far the best eyes are the anterior median ones, which are the only pair with a direct, postbacillar retina. In *Lycosidae* the posterior median eyes are the best, while in *Sparassidae*, spiders with laterigrade locomotion, the posterior lateral eyes are best.

6. *Changes involving the appendages.* Some of these changes we have already discussed. The changes which remain to be considered are those of relative proportions, special structure and subsegmentation. The relative proportion involves two items: the relative length of the successive legs and the relative length of the segments of the same leg. These changes are in direct correlation with the mode of life and locomotion. While often of familial

value, they are equally often of only subfamilial or generic value. Some of the greatest differences in the length and relative stoutness or slenderness of legs are found in the *Theridiidae*. There is also a certain optimum for the relative length of the legs. Considerable deviation from this optimum in either direction is apt to impede locomotion. Subsegmentation is characteristic only of spiders with very long, slender legs and affords a flexibility not possessed by the typical segment. It is limited to the tarsus and is common in *Pholcidae*.

#### (b) CHANGES OF GENERIC VALUE

Depending upon the definition of a genus the concept of generic characters varies. The general tendency among arachnologists for at least fifty years past is to restrict each genus, making several genera out of an originally single genus. It is impossible to establish a general rule, because the same character does not have the same value in different families. Thus the presence of only six eyes is a familial character in *Dysderidae* and *Oonopidae*, but only a generic character in *Pholcidae*. Practically every organ which furnishes familial characters may present in addition in one or another family generic characters. The extreme flatness of the cephalothorax is a familial character in *Platoridae* and *Selenopidae*, but fairly flat cephalothorax occurs in some genera of *Thomisidae*. On the other hand a peculiarly elevated cephalothorax is invariably a generic or at most a subfamilial character. Of late years many arachnologists tried to attribute generic value to characters derived from the structure of the male palp. It is true that certain types of palps are characteristic of certain families, but only in a general way. The structure of the external genital organs in spiders is universally recognized as one of the most important specific characters. Not only are such characters by their very nature restricted to a single sex, but their use as generic characters precludes their use in immature specimens. This consideration alone should be sufficient to rule them out as generic characters.

#### (c) CHANGES OF SPECIFIC VALUE

Such changes cannot be considered here in detail. They are too diverse and too many for satisfactory discussion in a brief outline.

But we may group the changes advantageously under three separate captions: changes common to both sexes, changes restricted to the male sex and changes restricted to the female sex.

1. *Changes common to both sexes.* These changes are often masked by changes found only in one sex. Nevertheless they may be recognized and are present already in immature individuals. Unfortunately we know so little about immature individuals of even quite common spiders that any speculation is out of place.

2. *Changes restricted to the male sex.* We have already mentioned the use of the male palp as a specific character. Although I have never published my own observations on specific variation of the palp I feel certain that many species established solely on the basis of minute differences in the palpal organ will prove to be mere variations. There is no reason why the palp alone among all organs should be exempt from variation. The idea occasionally met with in literature that the palp and the epigynum of spiders is an example of a lock and key adaptation is not substantiated by any evidence derived from a study of the organs themselves. The embolus and the conductor, if the latter is present, do not in any way correspond with the structure of the seminal receptacles and their ducts. Where a resemblance is present it is only superficial. For example, in *Agalena naevia* the embolus and the fertilization duct are both spirally wound, but the embolus is too thick to be introduced into the duct and is held during copulation in the atrium. The specificity of the relationship between male and female spiders is more of a physiological type. In other words the male of one species *could* introduce his embolus into the receptacle of a female belonging to another species, but does not try to do so because for as yet mysterious reasons he recognizes the fact that she is not of his species and avoids approaching her. Under the circumstances slight variations in the structure of the male copulatory apparatus may or may not have specific value. Each case would have to stand on its own merit and nothing but extensive study and breeding experiments could be decisive in each case.

One of the most common characters restricted to the male sex is the relative length of the legs when compared with the female. This character appears as a rule in the last instar, although slight differences often appear much earlier in life. In many cases there

is a tendency to an inhibition of growth of the body resulting in great discrepancy in size between the adults while younger instars remain more or less alike. In *Gasteracantha* and *Micrathena* the shape of the adult male is also very different from that of the female, the difference being chiefly restricted to the abdomen. The production of hooks on the coxae or on the tibiae is often a male sexual character as in many *Argiopidae*. Sometimes these characters are generic in value in the sense that a particular hook is present in the males of all species belonging to a certain genus. But specific differences usually are noticeable as in the case of tibial apophyses of male palpi.

3. *Changes restricted to the female sex.* The female usually retains youthful characters even after maturity. At the same time such characters are often accentuated after the last moult, especially in the case of the abdomen. There is an interesting difference in this respect between the two sexes. In the male it is usually the cephalothorax, in the female the abdomen which develops special features in the penultimate or in the last instar. Moreover, the differences are often, though not always specific. The size, number and disposition of abdominal thorns (usually spoken of as spines) in females of the genera *Gasteracantha* and *Micrathena* are specific in value, but are commonly wanting in the males. Similarly the cephalic turret of *Walckenaera*, the cleft head of *Argyrodes* are characters restricted to the male sex, yet presenting specific differences.

The structure of the epigynum in spiders which possess it, has been used for many years past as a specific character. The considerations dealt with in connection with the male palp as a character apply equally to the female epigynum. There is a general type common to several genera yet exhibiting specific differences. On the other hand the specific differences are often so slight that, in the case of a female, the determination of the species is rendered uncertain. Only our ignorance is responsible for this. The male spider makes no mistake in identifying the female of his species at the time of mating!

#### C. CHANGES IN HABITS

The habits of spiders have been used in the past for purposes of classification. The Genus *Uloborus* used to be placed in the same

family with the Genus *Epeira* because both construct a geometric orb web. Simon was the first to separate them because of differences in their spinning apparatus. On the other hand Simon placed the *Rhoicininae* in the Family *Lycosidae* because they carry their egg-cocoon Lycosa-fashion, attached to the spinnerets. I have shown in an earlier paper that *Lithyphantes oophorus* (Family *Theridiidae*) and *Centromerus origerus*, (Family *Limpyhiidae*) also carry their cocoon Lycosa-fashion, although certainly in no way related to the *Lycosidae*. How far habits can be used as indications of relationship remains questionable. Certain types of web construction are typical of certain families. Within each type specific variations are easily observed. Recently I had opportunity to study snare construction and other habits in tropical spiders. The paper is in process of preparation, but I may state here that within a specific pattern of behavior considerable variations occur. In other words, instinct is plastic and converging evolution of habit may be expected as well as diverging evolution. For this reason I do not consider as indicative of relationship the method of copulation so thoroughly studied by Gerhard, myself and others in many species. The position of the male and female may be much better regarded as a direct function of the available mechanism, not as a remnant of habit of a creature otherwise markedly changed in the course of evolution.

The life of recent spiders is very well known. What evolutionary changes have taken place in the habits of spiders since the Oligocene will remain unknown because the habits of fossil spiders are and mostly will remain unknown. Here and there a bit of web is preserved, but not enough to give an idea of the complete structure. Occasional cocoons have been described. In the present paper the hackled band of an *Amaurobius* is figured. The determination of the spider otherwise imperfectly preserved was made possible by the peculiar structure of this band. Other habits and functions may be safely assumed as having a pattern similar to that of recent species on the basis of similarity of anatomical structures. Moulting and autotomy, if judged by fossil exuvia and autotomised legs, followed the familiar pattern. We may also safely assume that Baltic amber spiders led the same life as their recent relatives; that some were vagabonds, some tube-weavers; some built reticular, some geometric orb-webs. The habits of spiders must have differentiated long before the Oligocene.



## VII. TAXONOMIC VALUE OF CHARACTERS

If fossil spiders were as well preserved as recent ones the taxonomic value of their characters would be the same. Unfortunately even in amber spiders preservation is not always perfect. Even apart from imperfections of the amber itself, opacity, bubbles, foreign inclusions, etc. making examination under microscope often difficult, certain structures which one would expect to see are rarely preserved. Thus the book-lungs are rarely visible while I have never yet seen the tracheal tubes in an amber spider. The tracheal spiracle is visible only in a few exceptional cases. The heart is never preserved. Thus the determination of the family depends of necessity to a great extent upon other characters. An error is therefore possible, but usually excluded by the combination of characters.

The same applies to subfamilies and genera. In some families the characters used for the separation into smaller groups are of a kind that permit their recognition without difficulty. When, however, it comes to such characters as the armature of the chelicerae, their position is such that a clear view is rarely possible. If the specimen is a mature individual and the genitalia are well preserved, the determination of the species is certain. When, however, the specimen is immature, the difficulty of identification is considerably increased. It is in such cases that detailed study of often minute characters becomes invaluable and decisive. On the whole the study of Baltic amber spiders compares favorably with the study of recent species. What is disconcerting is the fact that in the past Baltic amber spiders were studied before arachnologists understood the value of taxonomic characters and gave descriptions in much too general terms. I feel quite certain that if the method which I followed in the present study were applied to the celebrated Königsberg collection, hundreds of new genera and species would come to light. I feel also certain that a redescription of Koch's types is quite necessary, if one wishes to make his species recognizable without the process of matching new specimens with the types.

## VIII. RELATIONSHIP OF THE SPIDER FAUNA OF THE BALTIC AMBER TO RECENT SPIDERS

On account of the uncertainty of many types described by previous authors, our knowledge of the spider fauna of the Baltic amber is very incomplete and imperfect. Koch has described many species the generic affiliation of which Menge seriously questioned. He established genera insufficiently characterized, some of them invalid. He erected two new Families which have never been accepted by other arachnologists and are all but forgotten at present. It is difficult to say how much of Koch's work will survive. At the same time one must admit that both Koch and Menge were arachnologists of the first order and possessed great experience. While owing to the level of knowledge and to the method of description in vogue at their time they must have unavoidably made mistakes, at the same time, as my present study shows, they must have recognised correctly the familial and generic affiliations of many species. Koch described 106 species which he distributed over the following 11 families: *Archaeidae*, *Epeiridae*, *Mithraeidae*, *Therididae*, *Agelenidae*, *Drassidae*, *Eriodontidae*, *Dysderidae*, *Thomisidae*, *Eresidae* and *Attidae*. Few of these families are retained at present in their original limits. They are the *Archaeidae*, *Epeiridae* (now called *Argiopidae*), *Eresidae* and *Dysderidae* (the Family *Segestriidae* which I recognise is usually included as a Subfamily in the *Dysderidae* even at present). The *Mithraeidae* and *Eriodontidae* are the two families which I just mentioned as having no status at present. Koch's *Therididae* included also the *Mimetidae*, *Linyphiidae* and *Erigonidae*. His *Agelenidae* still included the *Hersiliidae*. His *Drassidae* was composed of the Families which are now divided into *Amaurobiidae*, *Drassodidae*, *Anyphaenidae* and *Clubionidae*. His *Thomisidae* still included the *Sparassidae*. Menge found in his own collection representatives of all Koch's families and added 62 new species. Later studies have not materially changed the list. The collections which form the subject of the present study contain representatives of all above mentioned families as defined at present, except for the *Hersiliidae*, *Anyphaenidae* and *Eresidae*. Koch and Berendt described and figured a single species belonging to the Family *Hersiliidae*, namely *Hersilia miranda*. They had a single speci-

men, but Menge states that his own collection contains two other specimens of this species. There can be scarcely any doubt as to the correct identification of the family, but the genus may have to be changed when the type specimen is reexamined. The case of *Anyphaena fuscata* Koch and Berendt is not so clear. Menge agrees with Koch in the determination of the genus. But the characters of the Genus *Anyphaena* and of the Family *Anyphaenidae* as delimited at present require the study of the tracheal spiracle. As explained above, the spiracle is rarely visible in amber spiders and is not even mentioned in the description of the species. This leaves a serious element of doubt in the definition of both genus and family. Two species, *Eresus monachus* and *Eresus curtipes* were described by Koch and Berendt and placed in the Family *Eresidae*. In the description of the species neither the cribellum nor the calamistrum is mentioned. Koch included in his Family *Eresidae* two genera, *Eresus* and *Palpimanus*. The latter genus has no cribellum and is now the type of the Family *Palpimanidae* representatives of which have not yet been found in the amber. Koch gives figures of the spiders and of the eyegroup of *E. monachus*. The shape of the body and the eyegroup are two of the important characters of the family. Unfortunately Menge states in a note on page 88 that the eyes in both specimens cannot be seen clearly ("Die Augen sind an beiden Exemplaren der Berendt'schen Sammlung nicht mit Bestimmtheit zu erkennen"). In the same note Menge also objects to the separation of the *Eresidae* from the *Attidae* (*Salticidae*). "Uebrigens stehen die *Eresiden* den *Attiden* so nahe, dass ich es nicht wohlgethan finde, eine besondere Familie daraus zu bilden." I think the probability is in favor of both species belonging to the Genus *Eresus*, but confirmation can come only from a re-examination of types.

Koch recognized the specificity of the Baltic amber fauna. In the Introduction he pointed out: 1, that all species found in the amber are extinct, 2, many genera are quite analogous to the recent ones ("den jetztweiligen vollkommen analog sind"), while others are extinct, and 3, that some of the genera are at present represented only in the tropics. In these respects my study fully confirms Koch's conclusions. Not one of the species described below can be placed in any of the recent species. Most of the extinct genera are distinct from recent ones, yet closely related to them. There are, of course, the five families new to science and

having representatives only in the Baltic amber. But whether these families can be retained, or will have to be subordinated to known families as new subfamilies cannot be decided at present. Many of their characters resemble those of recent families. Then, again, we must remember the case of *Archaea*. Koch described the Genus on the basis of fossil species found in the amber, but others have later discovered recent species undoubtedly belonging to the same genus. Finally, while some of the genera common to the amber and recent faunas are found throughout the world, others are found elsewhere than in Europe. *Archaea* is at present represented in South Africa, Madagascar and Australia. *Hersilia* mentioned by Koch is at present distributed over Africa, Madagascar and tropical Asia. *Auximus* is found in the Azores, St. Helena and South America. The Family *Psechridae* of which I give the description of a new Genus and Species from the Baltic amber is at present found in Africa, Southern and Southeastern Asia, Malaysia, New Zealand, New Guinea, Australia and Central America, but not in Europe. To this must be added the fact that some genera represented only in the Baltic amber have their nearest relatives not among European but among exotic spiders. Thus the two new genera of the Family *Salticidae*, *Eolinus* and *Paralinus* are closely related to the recent Genus *Linus* which is found in tropical Africa, Southern and Southeastern Asia, Malaysia, but not Europe. The Genus *Facundia*, Family *Thomisidae*, is closely related to the Genus *Bomis* now found in Australia. The same applies to the Genus *Fil-iola* which is also closely related to *Bomis*. The Genus *Eostasina* of the Family *Eusparassidae*, as the name implies is closely related to the Genus *Stasina* distributed through tropical Asia, the Philippine islands, tropical Africa and tropical America. The Genus *Col-lacteus* of the Family *Eusparassidae* is related to the Genus *Zachria* which is found in Australia. The Genus *Myro* of the Family *Agelenidae* is found in South Africa and the Kerguelen Islands. The Genus *Esuritor* of the Family *Pisauridae* is related to the Genus *Voraptus* found in the Seychelle islands, and tropical Africa. The Genus *Annarius* of the Family *Zodariidae* is related to the Genus *Patiscus* found in South Africa. This is a sufficient array of facts establishing the exotic relationship of the Baltic amber spider fauna. But how about their relationship to the recent Central European fauna? The latter contains several hundred genera only nine of which are also found in the Baltic amber.

Are we to assume a complete destruction of the Oligocene fauna and a later invasion of Europe from other countries? Or are we to suppose that recent true European genera are direct descendants of extinct Oligocene genera? In that case we should be able to trace the origin of many such genera. Moreover, granted sufficient fossil material, we should be able to answer the question as to whether new genera may be formed only by what Goldschmidt calls macroevolution, or whether their formation through gene mutation, through microevolution is also possible. In the latter case we would expect to find many traces of resemblance between descendant and ancestor. On the other hand, in case of macroevolution with a sudden change of a then existing type into a "hopeful monster" directly representing a new genus or even family, we would expect less resemblance and the complete extinction of original genera.

The answer to these questions is not as simple as it may seem to be at first glance. One of the chief difficulties lies in the concept, the scope and the definition of a Genus. For this reason perhaps the best way to approach the problem will be to consider first those genera which are common to both the Baltic amber and the recent fauna.

I have mentioned above that 12 such genera are represented in the collections which I have studied. Five of these are used by me only provisionally because the condition of the fossils is not good enough for a recognition of all necessary generic characters. This leaves us seven genera, *Amaurobius*, *Auximus*, *Archaea*, *Ero*, *Dysdera*, *Segestria*, and *Orchestina*. Let us consider the Genus *Auximus* first. This genus was established by Simon in 1892 for several species which were placed before then in the Genus *Amaurobius*. The definition of the genus gives merely the characters by which *Auximus* differs from *Amaurobius*. These are a slightly lower cephalothorax, disposition of eyes and difference in the size of the eyes of the first row, the median being much smaller than the lateral ones, the clypeus lower than the anterior lateral eyes, retromargin of chelicerae with 4-5 teeth and other characters of the chelicerae limited to the male sex. Now *Auximus succini* described below conforms with the definition of Simon except for one character which Simon did not include in the definition, but which he used in the key for the separation of *Amaurobius*, *Auximus* and three other allied genera from the spiders which now are grouped

in a separate Family *Dictynidae*. In *A. succini* the fourth coxae are separated by two-thirds of their width, while according to Simon's statement on p. 232 (47) these coxae are contiguous in all above allied genera, including *Auximus*. The Genus *Archaea* has been emended by Simon to include the single then known recent species from Madagascar. Although as I have shown elsewhere (38), Simon's description of the characters of the family were at fault in several respects, the genus as emended by him is clearly defined and is applicable to two other species not known to Simon. Whether the species from Madagascar, *Archaea* (*Eriauchenus*) *workmani* Cambridge should be retained in the Genus *Archaea* or removed to its original Genus *Eriauchenus* is largely a matter of opinion concerning the value of some of the characters. The Genus *Ero* of the Family *Mimetidae* is separated from *Mimetus* by a higher clypeus and less disproportionate legs, while both these genera are separated from other genera by a much longer lip, disposition of the eyes and spination of legs. I think there is no doubt that the two species which I refer to the Genus *Ero* show the characters given by Simon, but there are slight discrepancies, and the matter of the relative length of the legs is one subject to individual interpretation of their importance. The genera *Dysdera* and *Segestria* are interesting because they belong to the youngest evolutionary group of Dipneumone spiders as evidenced by the presence of only two pairs of cardiac ostia and a highly differentiated tracheal system extending into the cephalothorax and its appendages. They are genera which should have undergone the least change since their formation, representing as it were the end of evolution in that suborder. Unfortunately some of the characters cannot be seen and others may be subject to wrong interpretation. For example, all recent species of *Segestria* have the third leg directed forward, wherein they differ from spiders of all other families. In *Segestria elongat* Koch and Berendt one specimen has all legs directed forward, which may be due to struggling in the fluid gum, the other specimen gives almost the appearance of a laterigrade spider evidently also due to struggling. At the same time their cheliceral margins are smooth while in recent species the retromargin has two strong teeth. In this respect the species is more like an *Ariadna*, but other characters preclude their inclusion in that genus. So it may be said that slight changes have after all taken place.

The Genus *Orchestina* of the Family *Oonopidae* also belongs to the younger branch of the Suborder *Dipneumonomorphae*. *Orchestina baltica* described below and represented by several well preserved specimens has the characters typical of the genus, dilated posterior femora adapted for jumping, the proportion of the legs and the leg formula, the disposition of the eyes, the height of the clypeus. Yet the lip is about as long as wide at base and the terminal joint of the male palp is about as large as the tibia. So in this case also slight discrepancies are observable.

It would be scarcely advisable to discuss every fossil genus newly established here and to compare them with their closest relatives among recent genera. I intend to consider only a few cases, selecting such genera as have relatives among the recent European spiders. We will begin with the Family *Salticidae* because it is the largest and widest distributed Family among recent spiders. Representatives of *Salticidae* are found in all climates, on all continents and islands, at all altitudes. They are dispersed primarily by ballooning. Evidently capable of adapting themselves to all kinds of climatic and environmental conditions most of them are, nevertheless, restricted in their distribution.

Thirty-six genera of *Salticidae* are listed by Berland and Fage in the posthumous volume of Simon's *Arachnides de France*, and 39 genera are listed by Reimoser for the entire palaearctic Region. Of the five genera of Baltic Amber *Salticidae* described below, *Cenattus* cannot be placed with certainty in any subfamily because of the poor preservation of the required subfamilial characters, while *Paralimus* and *Eolimus* have no close relatives in Europe. *Parevophrys*, as the name implies, is related to *Evophrys*, a genus which I place in the unidentate Subfamily *Heliophaninae* and which is widely distributed throughout Europe, Africa, America and Japan. Berland and Fage list 22 species of *Evophrys* found in France. *Parevophrys* may be differentiated from *Evophrys* by the following characters: eyegroup wider behind than in front, eyes of second row distinctly nearer ALE than PLE, sternum considerably narrowed in front, lip longer than wide, (leg formula probably 4312), first tibia with prolateral and retrolateral spines, second tibia with three pairs of ventral spines, third and fourth tibiae with three prolateral, three retrolateral and three pairs of ventral spines. All these characters could have been easily changed by displacement, as in the eyegroup, or by dropping of spines

giving rise to species with the characters of *Evophrys*. In that case we would have also to assume that *Parevophrys* existed in the Oligocene not only in Europe, but in other countries as well, giving rise to similar changes in all countries, or else have to explain the presence of *Evophrys* in other countries by later invasion from Europe. I think the second possibility less probable and feel certain that the changes from *Parevophrys* to *Evophrys* do not require the agency of other causes than gene mutation or changes of locus, *i. e.* fall within the definition of Goldschmidt's microevolution.

The case of *Gorgopis* is different. The characters of this Genus are such that it is impossible to consider it as closely related to any recent genus. I place it in the Subfamily *Itatinae* because both cheliceral margins are smooth, the fourth leg longer than the third, the sternum broad in front and the eyes of the second row much nearer to the ALE than to the eyes of the third row. But beyond this, relationship is obscure and I am led to believe that *Gorgopis* is one of those genera which did not leave descendants or else changed so fundamentally that the descendants lost all resemblance to the ancestors.

We next shall consider the Genus *Paruroctea*. Its familial affiliation is beyond dispute. The family *Urocteidae* is of special interest because, as explained on previous pages it probably originated from the Family *Oecobiidae* through the loss of the cribellum and calamistrum and a slight modification of other characters. The family contains at present a single genus, wherein it is similar to the *Oecobiidae* which also contain only the Genus *Oecobius*. Both genera, *Oecobius* and *Uroctea*, have a wide and fairly similar, though not identical distribution. Both are found in such widely separated regions as the Mediterranean and Japan. *Oecobius* has besides been found in America, *Uroctea* in Africa. I know the habits of *Oecobius* and find nothing extraordinary in its sudden appearance in places where it had not been captured before. Now in view of the fact that both families are represented by a single genus each, the definition of the genus is reduced to a minimum. Thus Simon gives it in the following words: "Oculi aream transversam occupantes et lineas duas, plus minus procurvas, designantes, medii antichi reliquis majores, medii postici inter se quam a laterilibus multo remotiores. Pedum metatarsi tarsiue subtus biseriatim aculeati" (p. 451). Referring merely to this definition



of *Uroctea* we could say that *Paruroctea* is differentiated from it by the first line of eyes being recurved instead of procurved, anterior median eyes scarcely if at all larger than the others, anterior metatarsi with only 0-2 ventral spines and tarsi without any spines, while posterior metatarsi with 2-2 ventral spines and tarsi with 2-2-2 short, ventral spines. When one compares specific descriptions one finds some other small differences between the characters of *Paruroctea blawveldti* and those of *Uroctea durandi*. But all differences are still of the same order as those which we have already seen in *Parevophrys* and the conclusion must be therefore the same. If *Paruroctea*, as seems probable, is the ancestor of *Uroctea*, only microevolutionary changes were required to produce the new genus from the old one.

We now take the case of *Adamator succineus*, the Baltic amber representative of the Family *Zoropsidae*. I have restricted this family to five genera, removing *Acanthoctenus* to a family of its own. The distinction of the genera is based primarily on the eyes and on the spines of the anterior tibiae. The Genus *Adamator* resembles most the Genus *Zorocrates* known only from Central America. It differs from it by the configuration of the eyegroup and by the presence of only a single row of ventral spines on the anterior tibia. Since two rows of ventral spines is undoubtedly the more primitive character, we could derive *Adamator* from *Zorocrates*, but not vice versa. Nor could we derive *Zoropsis* from *Adamator*.

We could extend these observations to other genera of spiders and would find in every case that either the differences are small enough to be explained on the assumption of microevolution, of small changes comparable to those responsible for the formation of new races; or else the changes must have been so great that all traces of an evolutionary relationship have been lost. In other words we have to assume that in the latter case all or most of the specific and generic characters have been lost and new ones produced in their place by a sudden substitution. How can we in that case be certain that this is exactly what has happened? That the "connecting link" has not been simply lost, but has never existed? That an ape has suddenly given birth to a human babe? A reptilian egg developed into a feathered bird or an egg of a Liphistiomorph spider into an Arachnomorph spider? If this question can ever be answered, it will be answered either directly

by a chance observation or a successful experiment, or else indirectly on the basis of probability of several possible solutions.

In the case of spiders, as far as I am aware, we have only two instances which permit reasonable discussion. These are the much discussed *Acanthoctenus-Ctenus* and *Oecobius-Uroctea* relationships. Since there is only one Genus of the Family *Oecobiidae* and only one of the *Urocteidae*, the comparison is not difficult. The two have the following characters in common: their abdomen is entire, chelicerae diaxial with both margins smooth, heart with three pairs of ostia, one pair of lungs, tracheal spiracle near spinnerets and tracheal tubes limited to the abdomen, eight heterogeneous eyes in two rows, free lip, converging maxillae, three tarsal claws, serrated bristles at end of the tarsi, two-jointed anal tubercle with a long fringe of hair, the peculiar shape of the posterior spinnerets, the shape of the carapace and the structure of the web.

The differences are as follows: the *Uroctea* species are much larger in size than the *Oecobius* species, the eyegroup and the shape of the PME is different, the legs are without spines in *Oecobius*, with spines in *Uroctea*, trichobothria are more numerous in *Uroctea*, the upper claws are similar in *Oecobius*, but slightly dissimilar in *Uroctea*. Finally the most conspicuous difference is that *Oecobius* has a cribellum in front of the spinnerets and a calamistrum on the fourth metatarsus, both wanting in *Uroctea*. Instead there may be present a colulus in front of the spinnerets, or it may be wanting, and of course a calamistrum is always wanting. Other less important differences exist, but we need not consider them. None of the differences enumerated above would be considered as insurmountable evidence against their origin by a process essentially similar to speciation, as I think Goldschmidt himself would admit. But it may be argued that the change represents the end of evolution in this line and that nothing more can be expected from the *Urocteidae*. That is as it may be, but I think that a new family still could be produced by the loss of a pair of cardiac ostia and a complete loss of the tracheal system or on the contrary, its greater specialization and extension into the cephalothorax.

The case of the *Acanthoctenidae-Ctenidae* relationship is more complex owing to the fact that the Ctenidae are subdivided into three subfamilies with a large number of species in various parts of the world. However, in other respects the case is simpler

because, with the exception of the cribellum and calamistrum, all other familial characters are almost identical, the differences in the *Ctenidae* being of subfamilial or generic value. Here further evolution could also be visualized as more or less of the same character as in *Urocteidae* and requiring no different methods of origin.

These are the only two cases which can be argued without passing into the realm of imagination and abandoning all factual evidence. Of course, the disappearance of a pair of cardiac ostia or of lungs may have been and very possibly was sudden, but there is no fundamental difference between that and the disappearance of a pair of eyes, unless, indeed, the entire physiological function of the organism has been changed. The problem is reduced to the question as to the genetic apparatus which controls the embryonic development of such structures. There must exist a broader law underlying all morphogenesis and in no way contradictory to the laws governing speciation.

The questions concerning the relationship of the spider fauna of the Baltic amber to recent ones of various geographical regions and the origin of the present Central European spider fauna must remain open to discussion until greater material becomes available. As stated above the spider fauna of the Baltic amber shows distinctly exotic affiliations. This is emphasized by the presence in the amber of species belonging to recent families which are not represented in the present European fauna, such as *Psechridae*, *Archaeidae* and *Hersiliidae*, or closely related to genera which do not occur in Europe, such as *Linus* and *Bomis*. The recent representatives of these spiders are found in the southern tropical and subtropical regions of the Eastern hemisphere. The complete extinction of all species found in the Baltic amber and the comparative paucity of material make it inadvisable to attempt even a suggestion of a closer affiliation with some particular geographical region. The tropical regions all over the world abound at present in species of Mygalomorph spiders. The farther the countries are situated from the tropics, the smaller is the number of Mygalomorph spiders. At present there are on the Mediterranean islands and on the European coast of that sea 53 species of Mygalomorph spiders. They are distributed over 4 families as follows: *Ctenizidae*—6 genera with 39 species; *Dipluridae*—2 genera with 5 species; *Theraphosidae*—2 genera with 6 species; *Atypidae*—1 genus with 3 species. The number is considerably greater

if the African and the Asiatic coasts of the Mediterranean are taken into account. On the other hand not a single species of Mygalomorph spiders has been found in the Baltic amber. This does not mean that they did not live in the Oligocene in the Baltic region, but rather that they escaped being caught in the fluid resin owing to their habits. The *Ctenizidae* are either simple burrowers in the ground or else so-called trap-door spiders. The *Dipluridae* are weavers of strong, irregular webs. The *Theraphosidae* are either burrowers in the ground or weavers of strong webs. The *Atypidae* are either burrowers in the ground or so-called purse-web weavers. Only mature males of Mygalomorph spiders are vagabonds and few, if any Mygalomorph spiderlings disperse by ballooning. The majority of the genera of Arachnomorph spiders found at present in Europe are also wanting in the Baltic amber. As pointed out above, 5 of the 27 families represented in the Baltic amber are extinct. Of the 62 genera described in this paper, 50 are extinct representing 80.6% of the total. The percentage of extinct genera is probably even greater owing to the fact that some species were described under recent genera because of poor preservation preventing clear recognition of generic characters. In view of the extent of the last Glacial Period in Europe it is difficult to envisage a survival of the Baltic amber fauna. The conclusion seems inevitable that a new invasion of Central Europe took place from the South and South East, resulting in closer relationship between the faunas of the Mediterranean basin and of Central Europe than between the latter and that of the Baltic amber.

## IX. REMARKS CONCERNING THE DEFINITIONS OF FAMILIES AND GENERA

Complete definitions of and a key to all recent families and subfamilies of spiders will be found in Part One of my Catalogue of American Spiders (37). A new Family *Toxopidae* has been established by Hickman since the publication of my Catalogue. The characters of this family are different from those on the basis of which I have erected the five new families described below. The definitions of these fossil families conform with the general scheme followed in my Catalogue except for characters which are not preserved.

The definitions of recent genera will be found in the second edition of Simon's *Histoire Naturelle des Araignées*. The definitions of the new fossil genera are made so that they may be compared with Simon's keys. At the same time they are assumed to possess subfamilial and familial characters as given in my Catalogue, unless otherwise stated.

Koch's fossil genera are redefined here on the basis of species which I believe to belong to them. It was impossible to revise them on the basis of Koch's types because the types were not examined by me. The genera *Archaea* and *Gorgopis* are revised on the basis of characters derived from a study of specimens belonging to Koch's Species. The Genera *Syphax* and *Flegia*, as characterized here, are defined on the basis of new species, because I have not seen specimens which could be referred to any of Koch's Species. Yet I believe that the generic affiliation of my new species of *Syphax* and *Flegia* is correct and Koch's definition of these genera quite insufficient from a modern point of view. The Genera *Custodela* and *Captrix* are new, but have Koch's Species for types.

## X. DESCRIPTION OF BALTIC AMBER SPIDERS

### Suborder DIPNEUMONOMORPHAE

The characters of this Suborder, given in my Catalogue of American Spiders, are derived entirely from a study of recent species. Presumably they apply also to fossil spiders, at least to those found in the Oligocene and Miocene. The single correction which may have to be made has to do with the segmentation of the abdomen. In the fossil Family Arthrodictynidae based on a single specimen, the abdomen is clearly segmented. Whether that specimen is mature remains doubtful. It may be a rather young spiderling. In that case the segmentation of the abdomen may be only a juvenile character, just as some recent spiderlings show traces of abdominal segmentation which disappears with age.

#### FIRST BRANCH TRIONYCHAE

##### Family *Urocteidae*

This Family contains a single recent Genus *Uroctea*. Gourret described two fossil species from the French Ligurian, *Uroctea galloprovincialis* and *Amphiclotho breviuscula*. Neither familial nor generic characters are given in either case. The figures are quite misleading. The specimens are in the Marseille museum and until re-examined by a trained arachnologist must be considered as being of quite uncertain affiliation.

##### Genus *Paruroctea*, nov.

The genus clearly possesses the familial characters but may be separated from the recent Genus *Uroctea* by the following generic characters: the first row of eyes is slightly recurved. The AME are but little larger than the PME. Of the tarsi only the fourth pair have ventral spines. Serrated bristles on tarsi wanting. Type: *P. blauvelti*, n. sp.

##### *Paruroctea blauvelti* n. sp.

Plate L, Figs. 465 to 469, Plate LXIX, Fig. 618. (Named in honor of Mrs. Helen Hayden Blauvelt.)

One specimen in the C. R. Crosby collection of Cornell University. Holotype. Presumably an immature female. The specimen

is well preserved, with all appendages complete and no white emulsion to obstruct the view of any part of the spider. On the other hand there are many imperfections of the amber itself, which make a complete description impossible.

Total length without chelicerae and spinnerets 3.2 mm. Carapace (Fig. 465) more or less heart-shaped, 1.10 mm. long, 1.12 mm. wide between second and third coxae, where it is widest, gradually narrowed anteriorly. It is rather flat, with a level head and a gently sloping posterior declivity. The clypeus is visible from above and is not vertical, but inclined forward. A few very long bristles form a longitudinal median row on the head.

The eyegroup is distinctly narrower than the carapace in that region, is transversely ellipsoidal and is situated on a very low common eye tubercle. The width of the carapace in the eyeregion is 0.90 mm., while the width of the eyegroup is only 0.36 mm. Eight eyes in two rows. The first row is slightly recurved, the second slightly procurved. Lateral eyes contiguous. The AME seem to be the largest, but the eyes are not sufficiently well preserved for exact measurement. Generally speaking the difference in the size of all eyes is very small. The quadrangle is somewhat narrower in front than behind and wider behind than long. The clypeus is somewhat higher than the length of the quadrangle. The thoracic groove is in the shape of a large, transversely ellipsoidal depression.

The chelicerae can be seen clearly only from in front, when they appear to be rather short and slender, converging on each other and distinctly shorter than the maxillae. The fang is quite short and slender. The margins are not clearly visible. There seems to be a single tooth on one of them, but it is not possible to determine on which, nor whether it really is a tooth. The maxillae are strongly inclined over the lip, but do not meet at their end. The lip is wider than long, with a rounded anterior edge and a straight suture.

The sternum (Fig. 466) is flat and nearly circular except for the straight anterior truncature. However, the presence of an air-bubble prevents a clear view of the posterior end of the sternum, so that it is impossible to decide whether the posterior edge is rounded or ends in a short point. The sternum is sparsely clothed with brown hair which is directed inward on the main surface of the sternum, but outward along its edge.

The first coxae are wide apart, separated from each other by more than the combined width of the lip and maxillae. The fourth coxae are separated by at least half their width. The coxae increase in size from the first backward, so that the first coxae are the smallest and the fourth the largest. None of the trochanters are notched. The palpi are of the female type, very stout, clothed with stiff hair and spines especially noticeable on the terminal joint. The palp is inserted close to the base of the maxillae. The palpal claw (Fig. 468) is similar to the tarsal proclaw. The legs are stout.

The leg formula	4	1	2	3
	3.4	3.2	3.1	2.9

	Femur	Pat. + Tib.	Metat	Tarsus	Total
I	1.00	1.20	0.72	0.56	3.48
II	0.96	1.12	0.72	0.56	3.36
III	0.92	1.00	0.72	0.56	3.20
IV	1.08	1.20	0.88	0.56	3.72

Width of first patella 0.240. First tibial index 20.

Width of fourth patella 0.240. Fourth tibial index 20.

### Spines.

First leg. Femur dorsal 0-1-1, prolateral 0-1-1, elsewhere 0. Patella dorsal 0-1 bristle, elsewhere 0. Tibia prolateral 1-1, elsewhere 0. Metatarsus ventral 0-2 apical, elsewhere 0. Tarsus 0.

Second leg same as first.

Third leg. Femur dorsal 0-1-1, ventral a row of 6 bristles, elsewhere 0. Patella dorsal 0-1 bristle, elsewhere 0. Tibia dorsal 1-1, prolateral 0, retrolateral 0-1, ventral 0-2 apical. Metatarsus ventral 2-2, elsewhere 0. Tarsus 0. Fourth leg same as third, but the tarsus has several very long dorsal bristles and 2-2-2 short ventral spines.

Three claws (Fig. 467). Upper claws dissimilar. Proclaw with 5 comparatively short and stout teeth. Retroclaw with 8 longer and more slender teeth. Third claw bent at right angles, short and stout, with a single tooth.

Claw tufts wanting. Serrated bristles wanting. Legs clothed with simple hair obliquely inclined forward and a few erect hairs placed at regular intervals. Trichobothria few. A row of two or three on tibia and metatarsus, none on tarsus.

Abdomen ellipsoidal, 2.2 mm. long, 1.8 mm. wide in middle,



clothed with short, fine hair. The dorsal wall of the abdomen is missing although the specimen lies considerably under the surface of the amber. It is not an exuvium and it is difficult to imagine how the loss of the dorsal wall was brought about. Perhaps the creature was not fully immersed in the still fluid gum and the dorsal wall remained exposed to the air until it disintegrated when a new layer of gum was added.

The spinnerets and the anal tubercle are very well visible and typical of the family (Fig. 469). The anterior pair is separated by about one-half their diameter. These spinnerets are cone-shaped. The median pair is both shorter and more slender. The posterior pair is comparatively long and their terminal joint is much longer than the basal one. The anal tubercle is fringed with long hair. A colulus is wanting. A tracheal spiracle may be clearly seen in front of the anterior spinnerets. It has the shape of a transverse slit and could be easily mistaken for a cribellum. However, it is certain that a cribellum is wanting. Nor is there any calamistrum on the fourth metatarsus. In other words, it is certain that the spider is a Urocteid and not an Oecobiid. The ventral surface of the abdomen is clothed with quite short simple hair. The view of the genital region is obstructed by a leg, but there seems to be no indication whatsoever of any epigynal structure.

The color of the chitin is dark brown, except for the abdomen which is almost white.

### Family *Pholcidae*

#### Subfamily *Miropholcinae*, nov.

The chief difference of this subfamily from the other six recognized by me consists in the fact that the eyegroup is as wide as the head, yet considerably elevated above the thorax. Moreover, either each triad is formed by the AME, ALE and PLE, or else, if they correspond to what is found in recent Pholcids, *i. e.* if they are formed by the ALE, PME and PLE, then the AME must have moved considerably backward until they came to lie in a row with the PLE. In either case it is a condition unusual in Pholcids. A further character is furnished by the extraordinary development of the fourth leg.

Genus *Miropholcus*, nov.

(*mirus*—marvelous, extraordinary)

With the characters of the Subfamily.

All eyes of the same size. Type: *M. heteropus* n. sp.

*Miropholcus heteropus* n. sp.

Plate XXXII, Figs. 300 to 307. Plate LXVIII, Fig. 613.

One specimen from Samland in the collection of the British Museum. Holotype. It is complete, but poorly preserved. The mouthparts and the sternum are covered with white emulsion. Inside the abdomen an opaque substance forms a large globe. The rest of the specimen is quite transparent. The chitin is of a very light buff color. The swollen palpi prove it to be an immature male.

Total length 1.5 mm. The carapace is 0.6 mm. long and 0.59 mm. wide in middle. Anteriorly and posteriorly it narrows down to about 0.36 mm. When the eyes are in focus they appear to project beyond the lateral margins of the carapace. Yet in reality the eyegroup is only 0.3 mm. wide, *i. e.* slightly narrower than the actual width of the carapace at its ventral margin (Fig. 306). The shape of the carapace is very peculiar (Fig. 301). It is highest in the middle. Posteriorly it slopes down at first gently, then forms a steep declivity. Anteriorly it slopes toward the head which is considerably elevated. On each side of the head, below the triad, a black, long and unusually stout bristle projects laterally at right angles to the carapace. A few fine hairs are present on the carapace.

All eyes are equal, round, 0.05 mm. in diameter. The triads are very prominent and far apart. Assuming that the AME form part of each triad we may say that the quadrangle is much wider in front than behind and wider in front than long. The eyes of each triad are contiguous. The eyes of the posterior row are more or less equidistant and the row is distinctly procurved. The clypeus is about as high as the diameter of the eyes.

The chelicerae are vertical, about as long as half the length of the carapace. They are parallel to each other and seem to be soldered at base, though this cannot be positively asserted. The fangs are not visible.

The ventral surface is badly obstructed from view by white

emulsion. Nothing can be said therefore about the mouthparts and the sternum. Of the coxae only the fourth pair are visible and are separated by about half their width. The most remarkable feature of the spider is the extraordinary development of the fourth legs which are much longer and stouter than the other legs.

Leg formula	$\frac{4}{4.8}$	$\frac{1}{3.9}$	$\frac{2}{3.1}$	$\frac{3}{2.3}$
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	Femur	Pat. + Tib.	Metat.	Tarsus	Total
I	0.64	0.68	0.64	0.40	2.36
II	0.60	0.60	0.36	0.28	1.84
III	0.36	0.36	0.36	0.28	1.36
IV	0.96	0.84	0.64	0.44	2.88

The legs are sparsely clothed with fine, simple hair. Spines are wanting, but the following bristles are present on all legs: Patella dorsal 1-1. Tibia dorsal 1-1. On the fourth patella the so-called lyriform organs are plainly visible (Fig. 304).

Three claws, exceedingly small and visible only on the fourth left tarsus (Fig. 302). They are no longer than one-third of the width of the tarsus. The upper claws appear to be similar, bent in middle, with a single tooth. The third claw is bent at right angles and appears to be smooth, with a very fine end. Serrated bristles are wanting. A small trichobothrium can be seen in the middle of the fourth tibia, none elsewhere. The palp (Fig. 303) has a large, swollen terminal joint at least as long as the femur. Lyriform organs may be plainly seen on the patella of the palp.

The abdomen is more or less ovoid (Fig. 300), rounded in front and slightly overhanging the carapace. It is 1.04 mm. long, 0.64 mm. wide and is sparsely clothed with fine bristles. Six spinnerets. Anterior and posterior pair of the same size, cone-shaped (Fig. 305). Anterior pair contiguous, posterior pair separated by the width of the anal tubercle which is large and cone-shaped. The median spinnerets are very slender, cylindrical, much smaller in size. Under high power one can see on the terminal joint of the anterior spinnerets a few very fine spinning tubes.

#### Family *Archaeidae*

The characters of this family as given by Koch were already found to be inadequate by Simon. The latest revision will be found in my paper (38) in which will be also found a key to all

fossil and recent species. Unfortunately I overlooked one species of *Landana* described by De Lessert in 1938 from the Belgian Congo under the name of *L. kratochvili*, an omission which does not in any way invalidate the results at which I have arrived in the above paper. All known fossil species belong to the Subfamily *Archaeinae* characterized chiefly by the presence of eight eyes and six spinnerets. For the benefit of paleontologists I reproduce here my key to the fossil species of *Archaea*.

1. Head hemisphaerical, without neck. Eyes not much elevated. Abdomen almost globular, with parallel grooves, with hair. Chelicerae moderately long. Legs densely covered with curved hairs. Sex not mentioned.  
*Archaea hyperoptica* Menge.
- \* Head with a distinct constriction forming a short neck. 2
2. Head with two posterior angular projections. Abdomen with a pair of dorsal humps and posteriorly projecting beyond the spinnerets. Chelicerae comparatively short. Presumably a female. . . . . *Archaea conica* K. and B.
- \* Head rounded, without angular projections. Abdomen not projecting beyond the spinnerets. Chelicerae relatively long . . . . . 3
3. Abdomen egg-shaped or almost globular . . . . . 4
- \* Abdomen laterally compressed, with parallel furrows. Carapace granular. Chelicerae very long, strongly diverging. Males more slender than females. . . . .  
*Archaea paradoxa* K. and B.
4. Abdomen smooth . . . . . 5
- \* Abdomen with parallel furrows . . . . . 6
5. Head rounded, globular. Carapace smooth. Chelicerae twice as long as the head, without teeth, only with fine bristles. Abdomen egg-shaped. Sex uncertain. . . . .  
*Archaea laevigata* K. and B.
- \* Head longer than wide. Carapace slightly wrinkled. Chelicerae more than twice as long as head, with numerous spines. Abdomen globose. Female. . . . .  
*Archaea pougneti* Simon.
6. Abdomen with parallel furrows its full length. Carapace with isolated tubercles Female. . . . .  
*Archaea incompta* Menge.
- \* Parallel furrows only in the posterior region of the

abdomen. Carapace with granules arranged in rows forming a network. Female. *Archaea sphinx* Menge.

Genus *Archaea* Koch and Berendt, 1854

Type: *A. paradoxa* K. and B.

Since I considered it necessary to include the Genus *Landana* in the Family *Archaeidae* characters had to be found separating the two genera. These are: the difference in the structure of the head and the presence or absence of spines on legs. In *Archaea* the head is elevated and the legs are devoid of spines. Familial characters are the same in both genera.

*Archaea paradoxa* Koch and Berendt

Plate VII, Figs. 61 to 63, Plate LXI, Fig. 566.

Koch and Berendt, (21), 1854, p. 19, Pl. II, Figs. 8 and 9.

In view of the peculiar appearance and structure of the spider, Koch's description and figures are sufficient for recognition of the species. However, from the point of view of modern arachnology neither the description nor the figures are adequate. The description omits measurements and mention of finer detail, the figure shows only the general appearance of the spider and that with the legs arranged to give a pleasing appearance rather than to represent the actual specimen. For these reasons the following description, figures and photograph will satisfactorily supplement Koch's original description even though they are based on a study of a different specimen.

A female in the collection of the British Museum, In. 18748 (Klebs 506, No. 13874). Hypotype. The specimen was originally mounted in a cell. On removal it was found to be engraved on one side XIII B874. For the purposes of exposing the chelicerae it was found necessary to cut the stone and polish off the engraved number. Before this treatment the specimen presented difficulties of the following nature: 1) some black matter formed a regular sheet preventing all but a limited view of the spider, 2) white emulsion obstructed the view of the abdomen and 3) bubbles of air interfered with clear vision in several places. When the specimen was placed in cedar oil after polishing, the oil penetrating along natural fissures in the amber cleared much of the white emulsion and filled many air pockets making all structures clearly

visible. After careful study the specimen was again enclosed in gum dammar under a coverglass.

Total length with chelicerae 2.48 mm. Carapace 0.80 mm. long, 0.36 mm. high from the edge of the carapace to the highest point of the head in a vertical projection. Anteriorly the head slopes somewhat downward to the eyes. The clypeus is almost vertical. Below the chelicerae the head slopes somewhat backward. Posteriorly the head is perfectly rounded thus forming a distinct neck. The rest of the carapace slopes downward anteriorly and posteriorly, the posterior declivity being quite steep, but less so than the anterior declivity. The carapace is widest between the first and second coxae, its width here is 0.62 mm. Anteriorly the carapace has a transversely ellipsoidal foramen for the reception of the chelicerae. The full height of the clypeus, measured from the lower edge of the AME to the edge of the rostrum is great, but if measured only to the upper edge of the chelicer al foramen is somewhat less than the diameter of the AME. The sides of the thorax are granular, the granules forming more or less clearly defined rows running toward the legs. A few short hairs may be seen near the eyes and on the back of the head.

The dorsal view of the eyegroup is shown in Fig. 61. The first row of eyes is strongly recurved, 0.60 mm. wide. The second row is not as wide and the PLE are situated to the inside of the ALE and almost directly behind the AME. The eyes of the second row are much smaller than those of the first row, are more or less equidistant and the row is slightly procurved. Viewed from in front the first row is strongly downcurved. The AME are of the same size as the ALE. Their diameter is 0.06 mm. and the distance between the AME and ALE is 0.14 mm. The AME are very prominent, the ALE less so.

The chelicerae are strongly divergent, their basal joint is 0.96 mm. long. It is constricted at the base and bent downward in middle. Viewed from in front the outer (dorsal) edge of the basal joint is almost straight, the inner (ventral) edge forms an angle about three-fifths from base. Consequently the basal joint is stoutest in this place. The fang is long and curved. It reaches the inner angle of the basal joint. The margins are exceedingly short, but a row of 11 or 12 fine spines is situated on the basal joint, beginning immediately under the articulation point of the fang and extending proximally somewhat beyond the inner angle. These

spines are promarginal and each spine sits on a small tubercle. It is probable that in life they were not movable. Koch and Berendt figure smaller spines between the longer ones. But in the specimen under consideration here such shorter spines are wanting. There are no spines on the promargin, but 3 or 4 minute tubercles can be seen a little below the base of the fang.

The maxillae are very long, with almost parallel sides, arched over the lip and almost, but not quite meeting at their end. Viewed from in front the ends of the maxillae may be seen projecting below the inner angle of the basal joint of the chelicerae. The palp arises about one-fifth from the base of the maxillae when viewed from the side. Its point of origin is of the same character as in the recent *Archaea workmanni* from Madagascar, as described by me (38). In other words the palp originates on the outer surface of the maxilla, but so close to its upper surface that its point of origin may be easily misinterpreted. There is no fundamental difference between *Archaea* and other spiders in this respect. The similarity of *Archaea paradoxa* with *Archaea workmanni* is further enhanced and the correctness of my interpretation substantiated by the fact that the maxillae of the former species are as thick as those of *A. workmanni*.

The lip is much longer than wide, pointed, convex, reaching almost to the end of the maxillae.

The sternum (Fig. 63) is long and narrow. It has 3 lateral projections at each side, the first behind the first coxa, the third behind the third coxa. Posteriorly the sternum ends in a point behind the third coxae, the fourth coxae being almost contiguous. The first coxae are widest apart and largest in size. There is a distinct space separating each subsequent coxa of the same side from the preceding coxa.

Leg formula	1	2	4	2	
	6.4	4.7	4.1	3.1	
	Femur	Pat. + Tib.	Metat.	Tarsus	Total
I	1.76	1.92	1.08	0.32	5.08
II	1.40	1.40	0.64	0.32	3.76
III	0.92	0.84	0.42	0.32	2.50
IV	1.36	1.08	0.52	0.32	3.28

Width of first patella 0.126 mm. First tibial index 6.5.

First femur much stouter than the others. Fourth femur dis-

tinctly curved dorso-ventrally. Metatarsus of third leg with numerous short stout hairs which have the appearance almost of spines. However, true spines on legs are wanting. The legs are clothed with short, slightly curved hair. Trichobothria difficult to see. On the first leg one can see two small trichobothria on the tibia very close to its apical end. On the fourth leg one can see a row of three trichobothria on the tibia, the first just before middle, the third apical. On the fourth metatarsus there is a single trichobothrium about two-thirds from base. There are no trichobothria visible on the tarsi.

Three claws. On account of the position of the legs the structure of the claws cannot be ascertained, but it appears as if the upper claws had a single tooth each.

A palpal claw is wanting.

The abdomen is 1.13 mm. long, including the spinnerets, 0.90 mm. wide, 0.62 mm. high in middle where it is highest. The sides of the abdomen are plicated, the ridges extending full length and passing around posteriorly to the opposite side. Most of the ridges are continuous, but there are one or two present only at the back, but wanting on the sides. At the back the arrangement of the ridges is quite peculiar inasmuch as the first ridge is about half way from the anterior end of the abdomen, while the last ridge is three-quarters from the anterior end. The first ridge is transversely almost straight, the subsequent ridges more and more procurved, the last one almost in the shape of a hair-pin. The petiolus is clearly visible. Both dorsally and ventrally the abdomen is very sparsely clothed with short hair. Of the spinnerets only the anterior pair is visible, the view of the others being obstructed by white emulsion. The anterior spinnerets are cone-shaped, contiguous at base.

No trace of an epigynum can be seen.

The color of the chitin is generally light brown, the carapace darker than the rest.

#### Family *Mimetidae*

Genus *Ero* C. L. Koch, 1837

Type: *E. tuberculata* (De Geer)

This genus contains both recent and fossil species. Koch's original definition was emended by Simon (47). Koch and Berendt still placed the *Mimetidae* among the *Theridiidae* from which



they have long since been removed and set aside as a separate family. Koch describes two fossil species from the Baltic amber, *Ero setulosa* and *Ero sphaerica*. Menge lists in a note on page 33 three other species, *E. coronata*, *E. exculcata* and *E. quadripunctata*, without giving any description or figure. These three species may be good ones, considering Menge's experience as an arachnologist, but they remain *nomina nuda*.

Koch's species are quite inadequately described and very poorly figured. Neither the description nor the figures can be used for identification. For this reason the two species described below are placed under new names. Only a careful comparison with Koch's original specimens may settle the question of possible synonymy.

*Ero permunda* n. sp.

Plate X, Figs. 91 to 94, Plate LVIII, Fig. 537.

Type. One mature male in the collection of the British Museum, In. 18744 (Klebs 502, No. 13462).

Total length 2.9 mm. Carapace 1.45 mm. long, 1.39 mm. wide, widest and highest one-third from posterior end. It is rounded in front and behind and rather high. Thoracic depression half way between the highest point and the posterior edge. Posterior declivity steep. The surface of the carapace is smooth except for the presence of three rows of four short hairs each. The median row begins behind the eyegroup. The lateral rows begin behind the PLE and converge on the second median hair. There are also present one median hair in front of the AME and one lateral hair on each side between the PME and PLE. All these hairs have the appearance of pointed spines.

Eight round eyes in two rows (Fig. 94). Width of eyegroup 0.738 mm. First row recurved and somewhat shorter than second row which is procurved. AME very prominent, on a common tubercle. Lateral eyes contiguous. Quadrangle square. AME slightly larger than all other eyes which are equal. Diameter of AME 0.167 mm. They are separated by the same distance from each other as from the ALE. The PME are separated by four-fifths of their own diameter and by the same distance from the PLE. The clypeus is concave and almost as high as the quadrangle.

The chelicerae are parallel and slender. The maxillae are inclined over the lip. The lip is free, about as long as wide at

base. The sternum is more or less triangular. 0.52 mm. long, 0.48 mm. wide between first and second coxae. It is sparsely clothed with erect hair. The first coxae are wide apart, the fourth coxae are separated by the posterior end of the sternum.

Leg formula	1	2	4	3
	6.9	5.7	4.7	3.9

	Femur	Pat. + Tib.	Metat.	Tarsus	Total
I	2.72	3.28	2.40	1.60	10.00
II	2.32	2.68	2.00	1.20	8.20
III	1.60	1.92	1.40	0.80	5.72
IV	2.12	2.20	1.60	0.84	6.76

First and second femur and tibia slightly curved. Tibia much more slender than femur.

*Spines.* First leg. Femur dorsal 1-1-1-1-1, elsewhere 0, but on the retrolateral surface are numerous very short spines irregularly arranged and a median row of similar spines is present on the ventral surface. Patella dorsal 1-1, the first one at base, slender and only half as long as the apical one. Elsewhere 0. Tibia dorsal 1-0-1, prolateral 1-1-1-1-1-1-1, the fifth one counting from base the longest. Four short, hooked spines between the fifth and sixth, and between the sixth and seventh spines. Five short, hooked spines beyond the seventh spine. Retrolateral 1-1-1 long spines, ventral 0. Metatarsus (Fig. 92) dorsal 1-1-1, prolateral 1-1-1-1-1 long spines with short, curved spines between them arranged as follows: four spines between first and second, and between second and third, five spines between third and fourth, six spines between fourth and fifth, eight spines beyond the fifth. Elsewhere 0.

Second leg same as first except: Tibia prolateral 1-0-1-0-1-1-1. Of the short, curved spines there are only three between the penultimate and last spine, and also only three beyond the last spine, and none elsewhere. Metatarsus prolateral 1-1-1-0-0. Of the short, curved spines four are between the first and second and between the second and third spines and eight or nine beyond the third spine.

Third leg. Femur dorsal 0-1-1-1-1, first spine in middle, elsewhere 0. Patella dorsal 1-1, the apical spine twice as long as the proximal one. Elsewhere 0. Tibia dorsal 1-0, prolateral 0-1, retrolateral 0-1, ventral 0. Metatarsus dorsal 1 near base, prolateral 1 two-fifths from base, retrolateral 1 two-fifths from base, ventral 0.

Fourth leg same as third. There are no curved or hooked spines

either on the tibia or the metatarsus of the third and fourth leg. Nor are there any spines on the tarsi of any legs. A row of three trichobothria is present on all tibiae and on the fourth metatarsi. Three claws. Upper claws curved, smooth. Third claw also smooth.

Abdomen theridioid in shape, clothed with long hair resembling bristles and spaced by considerable intervals. The spinnerets are visible, but their structure cannot be made out.

The palp (Fig. 93) is well preserved. Its femur is long and slender, its tibia club-shaped, its terminal joint rounded with a paracymbium as figured.

The color of the chitin is more or less uniformly rufous brown, femora somewhat lighter, paracymbium almost black.

*Ero carboneana* n. sp.

Plate XII, Figs. 108 to 111, Plate LX, Fig. 557.

(Named in honor of Miss Mary Carbone)

Type. One mature male in the collection of the British Museum, In. 18755 (Klebs 513, No. 13398).

A well preserved specimen in almost colorless amber which however shows many fissures reflecting the light.

Total length 3.60 mm. Carapace 1.40 mm. long, 1.12 mm. wide between second and third coxae where it is widest, narrowed in front to less than the width of the eyegroup, so that the eyes protrude on the sides and in front of the clypeus. Thoracic groove in the shape of an almost circular deep depression. The carapace is highest a little behind the eyegroup, sloping forward and backward to the posterior edge of the thoracic depression where the posterior declivity begins. The latter is steep. There is exceedingly little pubescence of any kind on the carapace, except for a few bristles behind the eyegroup.

The eyegroup is 0.56 mm. wide. The eyes are in two rows. The first row is recurved, the second row straight. The AME are on a common tubercle and are very prominent. The lateral eyes on each side of the head are also on a common tubercle. The AME are slightly, but distinctly larger than the other eyes which are subequal. There is a deep cleft between the lateral eyes and the AME which are contiguous. The quadrangle cannot be measured, but appears to be square. The eyes of the second row are

equidistant, separated by about their diameter. The clypeus is as high as one and one-half diameters of the AME.

The chelicerae are fairly long (Fig. 110), rather slender, without boss, with parallel outer sides, but slightly concave beyond middle. The margins are oblique, but their armature cannot be seen. The fangs are short and slender. The maxillae and lip are set at right angles to the sternum and consequently cannot be measured. But in certain positions they can be seen clearly and thus a fair idea of their shape may be formed. The lip is longer than wide. The maxillae which are so long that they reach almost to the tip of the chelicerae converge over the lip and almost meet in front of it. The sternum (Fig. 109) is strongly convex. It is almost triangular, longer than wide in ratio 18:15, bluntly pointed behind between the fourth coxae which are separated by their width. First coxae wide apart. The surface of the sternum is smooth, free of pubescence.

The legs are thin and long. All femora are dorso-ventrally curved. The first femur is almost twice as stout as the fourth.

Leg formula	1	2	4	3
	7.2	5.8	3.8	3.2

	Femur	Pat. + Tib.	Metat.	Tarsus	Total
I	2.85	3.23	2.45	1.52	10.05
II	2.37	2.85	1.90	1.04	8.16
III	1.04	1.74	1.02	0.63	4.43
IV	1.36	1.92	1.32	0.65	5.25

Width of first patella 0.190 mm. First tibial index 5.9.

Width of fourth patella 0.155 mm. Fourth tibial index 8.1.

*Spines.* First leg. Femur dorsal 1-1-1-1, elsewhere 0. Patella dorsal 1-1, the first a short bristle, the second a long apical spine. Elsewhere 0. Tibia dorsal 1-0-1, prolateral 1-1-1-1-1-1-1 long spines, the first one-third from base. The short spines are slender and straight, not curved as in other species and irregularly arranged. Retrolateral 1-1-1-1-1, ventral 0. Metatarsus dorsal 1-0, near base, prolateral 1-1-1-1-1-1-1, the first near base, long spines. The short spines in the spaces between these long spines are typically curved and are arranged as follows: two short spines between the first and second and between the second and third long spines; three short spines in each of the next three interstices; seven spines

beyond the seventh long spine. Retrolateral 1-1-1-1-1, ventral 0. Second leg same as first except for the prolateral spines on the tibia and metatarsus, which are as follows: Tibia prolateral 1-1-1-1-1 long spines, the first one-quarter from base. No short spines between first and second and second and third long spines. Two short spines between the third and fourth and between the fourth and fifth spines; three short spines beyond the fifth long spine. All the short spines are of the curved type. Metatarsus prolateral 1-1-1-1-1 long spines, the first one at base. Two short spines between the first and second and between the second and third spines; three between the third and fourth; four between the fourth and fifth; eight beyond the fifth long spine. Third leg. Femur dorsal 1-1-1-1, elsewhere 0. Patella dorsal 1-1, the second spine apical and very long, elsewhere 0. Tibia dorsal 1-0, prolateral 0-1-0, retrolateral 0-1-0, ventral 0. Metatarsus dorsal 1-0, prolateral 1-0, retrolateral 1-0, ventral 0. Fourth leg same as third, except femur dorsal 1-1-1-1-1, patella retrolateral 1 bristle on angular projection.

All spines are rather long, slender and conspicuous. The legs are clothed with fine hair which has the appearance almost of bristles, especially long on the ventral surface of the femora, but not numerous anywhere.

Three claws. Upper claws similar, bent, with a single tooth. Third claw bent at right angles, smooth. There are some stiff bristles under the claws, but it is impossible to decide whether any of them are serrated. Trichobothria are few, comparatively short and difficult to see. On the third left tibia a row of three trichobothria is visible.

The abdomen is more or less theridioid in shape, pointed behind, overhanging the carapace in front. The abdomen is 1.40 mm. long, 1.20 mm. high in the highest region. The width cannot be measured on account of the shape of the piece of amber and the position of the spider. It is clothed with stiff, brown bristles on the back, the sides and venter being free of all pubescence. Six longitudinal pliations are visible on each side, each continuing as a transverse pliation on the dorsal surface. Although clearly visible these pliations are very shallow.

The six spinnerets are arranged more or less in the shape of a rosette and can be perfectly well studied under the microscope, but a drawing cannot be made on account of the position of the spider in the amber. The anterior spinnerets are cone-shaped,

stout, contiguous at base, preceded by a small colulus. The posterior spinnerets are shorter and more slender. They are separated by the base of the anal tubercle which is quite large, cone-shaped, with a distinct terminal segment. The view of the median spinnerets is obstructed by some white emulsion adhering to the posterior spinnerets. The entire group is surrounded by a circular fold.

The palp is quite long (Fig. 111), especially its femur, but also the tibia which is more or less club-shaped, nearly twice as stout at the end as at the base. There is a stiff and very long bristle at the end of the patella. The cymbium has also several very stout, curved bristles in its proximal half, while the distal half is clothed with much finer bristles. Near its base the cymbium has a rather long apophysis. The structure of the palp is clearly different from that of the preceding species.

Family *Erigonidae* (= *Micryphantidae*)

Subfamily *Gonatinae*

Genus *Egonatium*, nov.

Abdomen soft. Legs without spines. Lateral eyes contiguous and much smaller than AME. Quadrangle of median eyes square. Head normal. Clypeus as high as the diameter of the AME. Posterior declivity of the carapace steep. On the first and on the fourth metatarsus a single trichobothrium is present, situated considerably beyond the middle of the segment. Upper claws similar, slender, with a few fine teeth. Third claw strongly geniculated, with a single tooth. Type *E. minutum* n. sp.

*Egonatium minutum* n. sp.

Plate II, Figs. 16-19; Plate LVIII, Fig. 538.

Type. Pullus. Sedgwick Museum, University of Cambridge, England, No. C 6650.

A small, perfectly preserved specimen in quite clear, light colored amber.

Total length 1.20 mm. Carapace 0.60 mm. long, 0.48 mm. wide between second and third coxae where it is widest, 0.25 mm. wide in the region of the eyegroup. The highest point of the carapace is in the region of the first coxae. From this point it slopes very gradually forward. The posterior declivity is very steep. The shape of the carapace as viewed from above may be best under-

stood from the figure. The quadrangle of the median eyes is square. The lateral eyes are contiguous and considerably smaller than the median eyes. Viewed from the side the clypeus is as high as the diameter of the AME. The carapace is clothed with very few, long, widely spaced, erect hairs directed somewhat forward.

The chelicerae, as far as one can see, are typical of the family, considerably stouter a little in front of the base than either at the base itself or at the end. The margins cannot be seen and the same applies to the maxillae. The lip is very short. The sternum, viewed from the side, appears to be strongly convex, is pointed behind and at least as wide as long. The first coxae are wide apart, the fourth coxae are clearly separated by the posterior point of the sternum.

Leg formula	1	2	4	3	
	2.5	2.3	2.2	1.6	
	Femur	Pat. + Tib.	Metat.	Tarsus	Total
I	0.46	0.48	0.31	0.27	1.52
II	0.39	0.43	0.27	0.26	1.35
III	0.31	0.27	0.19	0.17	0.94
IV	0.41	0.39	0.27	0.24	1.31

The legs are sparsely clothed with hair. A few erect bristles are present, but no spines. One can see on all patellae the usual dorsal bristles one of which is close to the base and the other near the end of the segment. Trichobothria are few and present only on the tibiae and metatarsi (Fig. 18). On the tibiae there is a single trichobothrium situated before the middle. On the first and fourth metatarsi there is a single trichobothrium situated considerably beyond the middle of the segment, while on the second metatarsus it is situated close to the base. On account of the position of the third legs one cannot see the trichobothrium.

Serrated bristles and spurious claws are wanting. Three claws. Upper claws (Fig. 17) are similar, curved, slender, with four fine teeth each. Third claw also slender, but strongly geniculated and supplied with a single tooth.

The abdomen is ovoid, overhanging the carapace. On its dorsal surface it is sparsely clothed with more or less erect, white hair slightly directed backward. The ventral surface is clothed with much shorter white hair also directed backward.

The spinnerets are well visible and are typical of the family. They are arranged in the shape of a rosette, are cone-shaped, the anterior pair as long as, but stouter than the posterior pair. The anal tubercle is large.

The color of the chitin is generally a light yellow with darker, reddish patches in various places. The ventral surface is very light yellow. The bristles are almost white.

It is probably a very young spider, so that the sex cannot be determined.

No. 17628 of the Seeböhm's Bequest in the collection of the British Museum belongs probably to this species. Its total length is 1.2 mm. The proportion of the legs is the same and the claws are clearly visible and of the same type.

*Egonatium succini* n. sp.

Plate XXX, Fig. 289; Plate XXXV, Figs. 333 to 337; Plate LXVI, Fig. 595.

Type. Female. Collection from Samland, British Museum, In. 18943.

Except for the presence of three planes of fission reflecting light the amber itself is perfectly clear. The specimen, however, is heavily coated with white emulsion through which certain structures are visible in strong light, making their description possible.

Total length with chelicerae 2.40 mm. The carapace is 0.96 mm. long, 0.36 mm. high. Its width cannot be measured. The limits of the head are clearly outlined by the cephalothoracic sulci. The posterior declivity is steep. The AME protrude beyond the clypeus. The entire eyegroup is on a distinctly transversely ellipsoidal common tubercle. The AME are much larger than the others which are subequal. The AME are contiguous with each other and with the ALE. The eyes of the second row are equidistant (Fig. 336). The first row is recurved, the second row procurved. The quadrangle of medians is square. The clypeus is concave under the eyes, but becomes convex further down. It is somewhat higher than the diameter of the AME.

The chelicerae are rather unusually stout. They are somewhat shorter than the length of the carapace. Their armature is not visible (Fig. 337). The view of the lip and maxillae is badly obstructed by emulsion, but one gets the impression that the maxillae are slightly diverging.



The sternum is more or less triangular in shape. It is very wide anteriorly, so that the first coxae are quite wide apart. Posteriorly the sternum forms an almost finger-like process between the hind coxae which are separated by half of their width. The finger-like process itself is bluntly rounded. The surface of the sternum is only slightly convex.

Leg formula	1	4	2	3
	3.6	3.5	3.4	2.3

	Femur	Pat. + Tib.	Metat.	Tarsus	Total
I	1.20	1.04	0.76	0.44	3.44
II	1.04	1.12	0.64	0.44	3.24
III	0.76	0.68	0.40	0.40	2.24
IV	1.08	1.04	0.76	0.44	3.32

Spines wanting, but fine bristles present as follows: one dorsal apical bristle on the patella and one dorsal bristle on the tibia. The legs are clothed with stiff, almost erect hair and there are also shorter erect hairs on the tibiae, metatarsi and tarsi. These short hairs are coated with white emulsion through which the hairs may be seen in strong transmitted light. They appear then as shown in Fig. 333. The claws cannot be seen well. Of the trichobothria one can see only one on all tibiae about two-thirds from base.

The abdomen is more or less theridioid in shape, very high, overhanging the carapace. The spinnerets are arranged in a rosette, cone-shaped, typical of the family. The first pair is contiguous at base. The anal tubercle is much smaller than the spinnerets. The abdomen is sparsely clothed with fine bristles. The epigynum (Fig. 289) is clearly visible. It is rather small, with a short scapus.

Family *Amaurobiidae*

Subfamily *Amaurobiinae*

Genus *Amaurobius* C. L. Koch, 1837

Type *A. fenestralis* (Stroem)

Koch and Berendt described two species from the Baltic amber which they placed in the Genus *Amaurobius*, namely *A. rimosus* and *A. faustus*. The former seems to have been a well preserved female, but the description is inadequate and the epigynum has

not been figured. Moreover, the authors did not even mention either the cribellum or the calamistrum and referred the genus still to the Family *Drassidae* which, as now delimited contains only non-cribellate spiders. *Amaurobius faustus* is a very poorly preserved specimen and neither its description, nor the figure permit the recognition of the species. Menge states in a note on page 58 that he is in possession of a third species which he calls *A. spinimanus* and which according to him was represented in his collection by three mature males. Menge gave no description of the species except for the statement that "das dritte Tasterglied mit drei etwas gekrümmten Dornen versehen ist."

*Amaurobius succini* n. sp.

Plate XLII, Figs. 398 to 406, Plate LXVI, Fig. 597.

Type. British Museum collection from Samland, In. 18160.

Peculiar interest attaches to this piece of amber. It contains two exuvia of apparently the same spider, held together by numerous threads of silk. One of the exuvia has swollen palpi and may be therefore properly regarded as the last exuvium before maturity of a male specimen. The other exuvium is smaller, but has except for the palpi the same structure as the larger one. It may be regarded as the exuvium of the stage preceding the latter and representing therefore the antepenultimate instar. That both are exuvia and not deteriorated spiders is certain because of the manner in which the carapace was split off from the rest of the cephalothorax along its margin. Many spiders leave their exuvia in the web in which they live, where they hang until the wind tears the threads of silk and carries the exuvium away. I have seen in Panama as many as two exuvia of the same spider in the case of *Nephila clavipes* which I kept under observation. It is very probable therefore that the same condition applied to *Amaurobius succini* and that the wind carried the two exuvia from their original place to the tree where they were caught in the drop of gum.

The exuvia are not perfect. Some of the legs are missing, others are broken (not autotomised). Lost are also both calamistra with the fourth legs and the cribellum with the spinnerets. Under the circumstances it would be impossible to place the exuvia in the proper family were it not for the silk holding the exuvia

together. This silk shown in Fig. 404 is of two types. One type, not shown in the figure, is represented by simple, straight threads. The other type is characteristic of cribellate spiders and can be produced only by cribellar glands. It is therefore quite certain that the spider which produced it was a cribellate spider. Coupled with the characters offered by the shape of the carapace, the structure of the chelicerae, of the claws and the spination of the legs the evidence is overwhelmingly in favor of including the spider in the Family *Amaurobiidae*. The question of the proper genus is a more difficult one. For example, the distribution of the trichobothria and the shape of the maxillae do not agree with what we find in recent species of *Amaurobiidae*. On the other hand in absence of evidence derived from the structure of the abdomen (the abdomen is present, but as usual in exuvia is quite shrivelled making its study impossible) it seems to be most prudent to ascribe the species to a genus many of whose characters it possesses and which is widely distributed at present.

The color of the chitin is brown, the chelicerae almost black. Portions of the amber are opaque making examination difficult, but all parts shown in the figures may be seen in strong transmitted light.

The total length of the spider may be only estimated because of the shrivelled condition of the abdomen and may have been in life 5 or 6 mm. The carapace is 2.4 mm. long, 1.5 mm. wide in its widest place. It is almost rectangular (Fig. 398). The head is 1.3 mm. wide. The posterior margin is straight, the front gently recurved. The carapace is rather flat. Its highest point is about one-third from the anterior edge. From here on it slopes gradually downward toward the front.

The eyegroup (Fig. 402) is 0.96 mm. wide. The AME are somewhat smaller than the lateral eyes and are separated from each other by almost their diameter, although when viewed from another direction they seem to be contiguous. The lateral eyes are on a joint tubercle on each side of the head. They are contiguous. The PME are the most difficult to see partly because of their own transparency, partly on account of reflexions in the amber. The clypeus is almost equal to the diameter of the AME. It is impossible to measure the eyes in any position. When viewed from in front as shown in the figure one gets a picture of the entire

group. The first row of eyes appears then distinctly shorter than the second row. The first row is recurved, the second row pro-curved. The quadrangle is longer than wide and wider behind than in front.

The carapace is clothed with two kinds of hair: long, stiff, almost bristle-like hair on the head and slightly flattened, more or less recumbent hair of light color on the rest of the carapace.

The chelicerae (Fig. 401) are powerful, but not geniculated. A strong boss is visible from the outside (Fig. 405). The margins are oblique. Three pointed equal teeth are present at the proximal end of the promargin. Opposite them on the retromargin are also three teeth of somewhat unequal size, the median one being the largest. In front of the retromarginal teeth a row of 9 bristles forms a retromarginal scopula.

Except for the first right leg which is complete, the other legs are so broken up and twisted that it is useless to measure them.

	Femur	Pat. + Tib.	Metat.	Tarsus	Total
First leg	1.90	2.20	1.48	1.00	6.50

*Spines.* Femur retrolateral 1 apical, elsewhere 0. Patella prolateral 1, dorsal 1, elsewhere 0. Tibia dorsal 0, prolateral 1-1-1, retrolateral 1-1-1, ventral 0-2-2. Metatarsus dorsal 0, prolateral 0-1-1, retrolateral 1-1-1, ventral 2-2-2.

The legs have a setose appearance due to two kinds of hair with which they are clothed. One kind is inclined forward, the other erect at right angles. Both kinds are of the simple type.

Three claws (Fig. 403). Upper claws similar, curved, with a row of 9 teeth. Third claw strongly curved, with a single tooth. Claw-tufts, serrated bristles and scopulae wanting. There are no trichobothria either on the tarsus or on the metatarsus. Under high power (Fig. 406) one can see on the tibia several oblique rows of minute trichobothria.

The lip is more or less triangular, black. The maxillae are so strongly inclined over the lip that they meet in front of it. The sternum is much longer than wide (Fig. 399), but rather small when compared with the size of the carapace and chelicerae. It is sparsely clothed with stiff bristles. The abdomen, as stated above, is quite shrivelled as one would naturally expect of a dried exuvium. One can still see, however, that it is clothed with stiff and fairly long bristles.

The cymbium of the palp (Fig. 400), is very large and has a small claw at its end. There are also several bristles present on the cymbium. The palp is unquestionably one of an immature male.

The smaller exuvium is lighter in color, but otherwise similar to the larger one in every visible detail of its structure.

Two pieces of the original piece of amber were cut off and mounted on separate slides for the examination of the silk under high power.

Another piece of Baltic amber from Samland in the collection of the British Museum, In. 18149, also contains spider silk presumably of this species.

Genus *Auximus* Simon, 1892

Type *A. denticheilis* Simon

*Auximus succini* n. sp.

Plate VII, Figs. 57 and 58, Plate LVII, Fig. 527.

Type. Female. British Museum, In. 18727 (Klebs 484, No. 13463).

The original engraving on the amber, XIII B 463, had to be polished off to permit a clear view of the side of the spider. The amber itself is quite clear, but the specimen is heavily coated with white emulsion.

Total length with chelicerae 5.9 mm. Carapace 1.74 mm. long, 1.65 mm. wide in its widest region, 1.16 mm. wide in the region of the eyes. Only three eyes are visible and these only in a certain position of the piece relative to the incident ray of light. Two of them are evidently the AME and are contiguous. Their diameter is 0.10 mm. Judging by the position of the third visible eye it may be either the ALE or PLE. It is slightly larger than the other pair and is separated from the latter by their diameter. The clypeus is equal to the diameter of the AME.

The chelicerae are strongly geniculated and very stout. Their anterior surface is clothed with long brown hair. The promargin (Fig. 58) has a row of three teeth and a scanty scopula, the retro-margin a row of four teeth. The fang is stout, short and evenly curved. The lip, though not quite clearly visible, seems to be as wide as long and reaches approximately to the middle of the maxillae. The maxillae are wide in front, convex, with a heavy scopula which looks almost like a tuft. Notwithstanding the white

emulsion a serrula may be seen along the anterior edge of both maxillae. The sternum is more or less shield-shaped, very wide in front, pointed behind between the hind coxae which are separated by two-thirds of their width. The sternum is longer than wide in ratio 15:12, slightly convex and clothed with long hair. The first coxae are very wide apart.

Leg formula	1	4	2	3
	3.1	2.9	2.7	2.5

	Femur	Pat. + Tib.	Metat.	Tarsus	Total
I	1.68	1.80	1.20	0.80	5.48
II	1.28	1.60	1.00	0.72	4.60
III	1.44	1.40	1.00	0.60	4.44
IV	1.60	1.68	1.24	0.60	5.12

The legs are very spinose and thickly clothed with brown hair. It is impossible to give the complete distribution of the spines. However, the following spines may be mentioned. First leg. Tibia prolateral 1-1, retrolateral 1-1, ventral 2-2, first pair in middle, second apical. Metatarsus prolateral 1-1, retrolateral 0-2, ventral 2-2. Third and fourth metatarsi more spinose than first metatarsus. On the third metatarsus an apical verticellum of six stout spines is visible. Trichobothria numerous on tibiae, metatarsi and tarsi, increasing in length distally. On account of the position of the spider the calamistrum cannot be seen on either of the fourth metatarsi.

Three claws. Upper claws similar, with a row of six teeth increasing in length distally. The third claw is distinctly bent, apparently with but a single tooth. The palpi are of the female type and are thickly clothed with hair. Numerous short spines are present on the palpi, but whether a palpal claw is present or wanting cannot be ascertained.

The abdomen is 3.6 mm. long, 2.0 mm. wide, more or less ellipsoidal in shape, but distinctly flattened above. It is sparsely clothed with long brown hair between which a thicker coat of short brown hair is visible. The genital fold is plainly visible, but no epigynum can be seen. The tracheal spiracle is also plainly visible immediately in front of the spinnerets. The cribellum (Fig. 57) is divided by a median line. The anterior spinnerets are wide apart and large. They are heavily coated with white emulsion. The median spinnerets are cylindrical, slender and small. The

posterior spinnerets are as wide apart as the anterior ones, somewhat longer and more slender.

The color of the chitin is generally brown, the chelicerae almost black.

Family *Arthrodictynidae*, nov.

This new family had to be erected notwithstanding the fact that several of the most important characters remain unknown because of the poor preservation of the type. Thus not only the structure of the circulatory and respiratory systems has to be omitted from the definition of the family, but the shape of the carapace, the number and disposition of the eyes and the shape of the lip have to be left out of consideration. Were it not for the segmentation of the abdomen and the relative size of the spinning group the spider in question could have been placed in the recent Family *Dictynidae*. Unfortunately an examination of even the youngest spiderling of recent species of *Dictyna* fails to reveal any similarity between the ventral surface of their abdomen and that of the abdomen of *Arthrodictyna* described below. I am placing the new family in the Suborder *Dipneumonomorphae*, Branch *Trionychae*, because it is undoubtedly closer related to the Family *Dictynidae* than to any other recent or extinct family. This close resemblance except for the abdomen leads me also to believe that the spider had two lungs and a single tracheal spiracle as well as three pairs of cardiac ostia.

The characters of the Family *Arthrodictynidae* may be summarized as follows: Abdomen segmented, with two sternites occupying the anterior half of the venter. The spinning group occupies the posterior half of the venter and consists of a large, undivided cribellum and six spinnerets. The anterior pair of spinnerets is the largest, widely separated and directed inwardly, the median pair slender and small, the posterior pair half as big as the anterior pair, but like the latter wide apart and directed inwardly. The anal tubercle large, cone-shaped. Chelicerae with oblique margins without armature. Maxillae inclined over the lip. Sternum shield-shaped. Palpi with a claw. Tarsi with three claws. Upper claws dissimilar, both pectinate in a single row. Calamistrum full length of the metatarsus, composed of a single row of curved bristles. Integument with simple and barbed hair. A single trichobothrium on the tibia, none on metatarsi and tarsi.

Genus *Arthrodictyna*, nov.

With the characters of the family, to which the following characters may be added: Margins of chelicerae with a scopula of four hairs. Order of legs 1243. No spines on legs except patella dorsal 1 and tibia dorsal 1-1. Sides of abdomen longitudinally pliated. Type *A. segmentata* n. sp.

*Arthrodictyna segmentata* n. sp.

Plate XLIII, Figs. 407 to 414; Plate LXVII, Fig. 602.

This remarkable spider is represented by a single, poorly preserved immature and incomplete specimen in the collection from Samland in the British Museum, In. 18950. The previous owner polished off the entire carapace and half of the abdomen, as well as portions of some legs. Fortunately the ventral surface of the abdomen is complete and all four legs of the left side, the fourth right leg, the sternum, the left maxilla and palp and the distal halves of both chelicerae with the fangs are also well preserved and complete. The abdomen is displaced so that it forms an almost right angle with the cephalothorax. For obvious reasons the total length of the spider can not be measured, but it is probable that it was approximately 1.6 to 1.7 mm. The chelicerae (Fig. 408) are with oblique margins. On one of the margins one can see a scopula of four hairs. On the corresponding margin of the other chelicera the scopula is composed of only three hairs. One cannot determine, however, which margin it is. Marginal teeth are wanting. The fangs are rather slender and slightly sinuous. The lip is missing, but the sternum is complete (Fig. 407). Its measurement is difficult on account of the position of the spider in the amber, but it is approximately 0.46 mm. long, 0.40 mm. wide. It is more or less shield-shaped, flat, pointed behind, sparsely clothed with short hair. The left maxilla is complete with palp. From its position it is safe to conclude that the maxillae are strongly inclined over the lip, possibly meeting in the median line. The palp is of the female type, with a smooth claw (Fig. 410). The palp is inserted at the base of the maxilla. The first coxae are wide apart and large by comparison with the others. The fourth coxae are separated from each other by more than their width.

On account of the missing carapace of which only the left margin is partially preserved, the leg formula cannot be given. The order of the legs is 1243.



	Femur	Pat. + Tib.	Metat.	Tarsus	Total
I	0.80	0.80	0.60	0.48	2.68
II	0.72	0.72	0.48	0.36	2.28
III	0.52	0.52	0.36	0.32	1.72
IV	0.68	0.52	0.48	0.32	2.00

The legs are clothed with fine hair. Spines are wanting, but the following rather long and fine bristles are present on all legs: Patella dorsal 1 apical, tibia dorsal 1-1. The tarsi are with three claws (Fig. 411). Upper claws slightly dissimilar, the proclaw apparently more strongly bent than the retroclaw. The upper claws are with three or four fine teeth. The third claw is smooth. Under the claws two stout bristles are visible, but it is not possible to decide whether these bristles are simple or serrated. Scopulae and unguis tufts are wanting. A calamistrum is present on the fourth metatarsi. It occupies the full length of the segment and is composed of a single row of nine or ten hairs which are stouter than the other hair and typically curved (Fig. 414). A single trichobothrium is present on each tibia near the base, but none elsewhere.

The abdomen is 0.8 mm. long, 0.5 mm. wide. Although half of it as explained above is missing, the entire ventral surface and part of the left side are preserved (Fig. 409). There are two distinct sclerites in front of the cribellum. Both can be clearly seen when the specimen is examined in a special direction. The first of these sclerites has more or less the shape of a triangle the apex of which merges imperceptibly with the petiolus. The sides are distinctly curved. The posterior edge is straight and approximately two-fifths from the anterior end of the abdomen. There is a transverse, procurved line a little in front of the posterior edge of the first sclerite. Four short bristles are on the narrow field thus formed. The second sclerite is much wider than long, with a straight anterior edge and a recurved posterior edge which is approximately three-fifths from the anterior end of the abdomen. The cribellum is entire, without a trace of a median line. It has the shape of a low triangle whose apex is directed posteriorly. The anterior spinnerets are stout, almost cylindrical, with a small, rounded terminal joint. The longitudinal axis of these spinnerets cuts the longitudinal axis of the body almost at right angles due to the fact that the spinnerets are separated at their base by more than the width of the cribellum and are directed inwards toward the median line. The posterior spinnerets are considerably smaller

and more slender than the anterior ones, but have the same appearance and are also directed inwardly. The median spinnerets are quite small and slender, barely visible and inclined obliquely inwards and backwards. Owing to poor preservation it is impossible to see any spinning tubes on the spinnerets. But a number of spinose hairs (Fig. 413) are present on the basal joint of the spinnerets and around the terminal joint. The barbs of these hairs are plainly visible under high power. The anal tubercle is cone-shaped, unsegmented.

### Family *Psechridae*

No representative of this family has been as yet described among the fossil spiders of any part of the world. This may be due to the fact that few arachnologists are familiar with even recent species belonging to the Family *Psechridae*. What seems to be strange, however, is the fact that *Eomatachia latifrons* described below and undoubtedly belonging to the Family *Psechridae* must have been a fairly common species in the Prussian Oligocene and yet cannot be identified with any described species. It happens that the male palp is so characteristic that the species is easily recognizable. Koch may have placed it in some family which has nothing in common with the *Psechridae*—the conception of families at his time was very different from ours—but the mere description of the palp would have sufficed to make the recognition of the species possible. *Eomatachia latifrons* is represented by six specimens in the collection of the British Museum, all six mature males, four of them numbered by Klebs. Yet from Koch's descriptions and figures it is impossible to identify them with any of Koch's species.

### Subfamily *Matachiinae*

This subfamily was established by Dalmás in 1918 for two new genera *Matachia* from New Zealand and *Paramatachia* from Queensland, Australia. Its chief characters as given by Dalmás and recognized by me are: Claw-tufts wanting. Cribellum entire. Lip long. Anterior legs longer than posterior legs. This definition remains unchanged as the new Genus *Eomatachia* conforms with it in every detail.

The separation of the three genera may be understood from the following key:

1. Both rows of eyes straight. Quadrangle not much wider than long, nor much wider behind than in front. Calamistrum full length of the metatarsus ... *Paramatachia*
- \* First row of eyes slightly recurved, second row slightly procurved. Quadrangle much wider than long, wider behind than in front. Calamistrum not reaching beyond two-thirds of metatarsus ..... 2
2. Eyes subequal, anterior medians slightly smaller, separated from each other by about their diameter, posterior medians by much more than their diameter. Order of legs 1243 ..... *Matachia*
- \* Lateral eyes larger than median eyes, anterior medians subcontiguous, posterior medians separated from each other by their diameter. Order of legs 1423. Baltic amber ..... *Eomatachia*

Genus *Eomatachia*, nov.

With the characters of the Family and Subfamily. Separable from the other two genera belonging to the same Subfamily by the characters given in the key. Type *E. latifrons*, n. sp.

*Eomatachia latifrons*, n. sp.

Plate VIII, Figs. 64 to 68; Plate XLVI, Figs. 429 to 437; Plate XLVII, Fig. 438; Plate LVII, Figs. 531 to 533.

The British Museum has six specimens of this interesting spider, all mature males of about the same size. They are labeled as follows.

1. In. 18737. (Klebs 494, No. 13433)
2. In. 18733. (Klebs 490, No. 13396)
3. In. 18738. (Klebs 495, No. 13442)
4. In. 18719. (Klebs 477, No. 13405)
5. In. 17612. Seebohm's Bequest.
6. In. 29205. A. Théry collection.

Of these specimens I have selected as Type of the species the first in the above list because it is the best preserved one. Specimen 29205 of the A. Théry collection is the least well preserved one, yet undoubtedly of the same species with the type. Four of its legs have been cut off by the previous owner and the carapace

and abdomen are damaged. Specimen 17612 of the Seeböhm's Bequest is in a piece of very dark amber of peculiar shape. This makes its study difficult, but its specific affiliation is unquestionable. A detailed description of this specimen is given below. Specimen 18719 has peculiar interest. It is very well preserved in light colored and perfectly clear amber except for one plane presenting a wrinkled surface due to the stress on still viscous gum when the spider was trying to free itself from the sticky substance, exerting all his power and even breaking two of his legs.

Specimen 18733 is somewhat smaller than the type, having a total length of only 4.0 mm. It is very well preserved in clear amber and can be studied from every direction. It shows the calamistrum particularly well. While I give no detailed description of this specimen here, figures of it will be found on Plate VIII (Figs. 67 and 68), Plate XLVI (Figs. 434 and 435) and Plate LVII (Figs. 533). I designate this specimen as paratype. Specimen 18738 is still a little smaller. Its total length is 3.8 mm. It is shown on Plate LVII, Fig. 532. The abdomen of this specimen is covered with white emulsion. Otherwise the specimen is well preserved and shows all specific characters.

Description of Type, In. 18737 (Klebs 494, No. 13433).

Plate VIII, Figs. 64 to 66; Plate XLVI, Figs. 436 and 437, Plate LVII, Fig. 531.

Male. Total length 4.56 mm. Carapace 2.40 mm. long, 1.80 mm. wide opposite second coxae where it is widest. Anteriorly the carapace is considerably narrowed and measures in front only 0.96 mm. The carapace is fairly flat, with a deep longitudinal thoracic groove. The surface is clothed with long, brown hair and short, white hair. The latter is especially numerous along the lateral margins and in an area in front of the thoracic groove.

Eight eyes in two rows. Width of eyegroup 0.74 mm. *i. e.* narrower than the width of the carapace in the eye-region (Fig. 64). The first row of eyes is slightly recurved and shorter than the second row, being only 0.60 mm. wide. The AME are very prominent. The quadrangle of medians is wider behind than in front in ratio 14:10, wider than long in ratio 14:11. Ratio of eyes AME:ALE:PME:PLE = 5:6:5:6. Lateral eyes contiguous, on a common tubercle. AME subcontiguous. They are separated from the ALE by less than their diameter. PME are separated from each other by almost their diameter and by the same

distance from the PLE. The clypeus is vertical, six-fifths of the diameter of the AME.

The chelicerae are powerful, without boss. Basal joint 0.85 mm. long, clothed with brown hair on anterior surface. The two chelicerae are parallel to each other. Their margins are oblique, with a heavy scopula. Their armature is not visible. (NB. The armature visible in specimen 17612, q. v. The fangs are visible in specimen 18733. They are 0.24 mm. long, slightly curved, very pointed and black.)

Maxillae and lip poorly visible. (In specimen 18733 the maxillae are parallel (Fig. 67), with rounded end. The palp arises close to their base. The lip is longer than wide in ratio 15:10. It is truncated in front, with a few long hairs. The sides of the lip are bulging, so that the lip has the appearance almost of a hexagon.)

The sternum is more or less shield-shaped, slightly longer than wide, widest between the anterior coxae, pointed posteriorly. It is only slightly convex and is clothed with two kinds of hair: simple hair, brown, long, more or less erect; and plumose, recumbent hair. Coxae cylindrical, all of about the same size. First coxae wide apart. Fourth coxae separated by half their width. Trochanters not notched.

Leg formula	1 3.7	4 3.3	2 3.1	3 2.7		
	Femur	Pat. + Tib.	Metat.	Tarsus	Total	
I	2.80	2.84	2.16	1.08	8.88	
II	2.12	2.48	1.80	0.92	7.32	
III	2.24	1.92	1.56	0.76	6.48	
IV	2.20	2.60	2.20	0.84	7.84	

Width of first patella 0.264 mm. First tibial index 9.3.

Width of second patella 0.264 mm. Second tibial index 10.6.

Width of third patella 0.240 mm. Third tibial index 12.5.

Width of fourth patella 0.264 mm. Fourth tibial index 10.2.

The spines are long, stout and almost erect. Their distribution is as follows:

*First leg.* Femur dorsal 0-1-0, prolateral 0-0-1, retrolateral 0-0-1, ventral 0.

Patella retrolateral 1, elsewhere 0.

Tibia dorsal 1 beyond middle, prolateral 1-1-1, retrolateral 1-1-1, ventral 2-2-2.

Metatarsus dorsal 0, prolateral 1-1-1, retrolateral 1-1-1, ventral 2-2-2, the apical pair much smaller than the other two pairs.

*Second leg* same as first.

*Third leg.* Femur dorsal 0-1-1, prolateral 0-0-1, retrolateral 0-0-1, ventral 0.

Patella retrolateral 1, elsewhere 0.

Tibia dorsal 1 beyond middle, prolateral 1-1, retrolateral 1-1, ventral 0-2-2.

Metatarsus dorsal 1-1-1, prolateral 1-1-1, retrolateral 0-0-2, ventral 2-2-2.

*Fourth leg* same as third, except: Femur dorsal 0-1-0, Tibia dorsal 0, prolateral 1-0, ventral 2-2-2. Metatarsus retrolateral 1-1-1.

The legs are clothed with three kinds of hair: simple, long hair standing at an angle of about 30°, simple, short hair standing almost at right angles and plumose hair. The latter is present only on the coxae and femora. Trichobothria are numerous and long, in two rows on tibiae and metatarsi, in a single row on tarsi increasing in length distally. On the third and fourth tarsi there are also short, stout hairs having almost the appearance of spines, but devoid of serrations. On the first and second tarsi the hair is of the usual type.

Three tarsal claws. Upper claws similar, with a single row of 8 or 9 teeth. Lower claw very small, with 2 teeth. Claw-tufts wanting, but some stiff hair projects under the claws, presenting almost the appearance of tufts.

Fourth metatarsi with a calamistrum consisting of a single row of curved bristles and occupying the proximal two-thirds of the segment.

Abdominal ellipsoidal, 2.4 mm. long, 1.44 mm. wide, anteriorly overhanging the carapace. It is clothed above with both long and short brown hair coated with white emulsion.

The view of the spinning group is somewhat obstructed by the right fourth leg and by white emulsion. The cribellum cannot be seen. (NB. The cribellum is plainly visible in the paratype, In. 18733, Fig. 68. It is entire, without a trace of a dividing line. The anterior spinnerets are cone-shaped, contiguous at base—a feature unusual in cribellated spiders—with rounded terminal joints.

The shorter median spinnerets can be seen between the anterior pair when the spider is examined in a special direction. The posterior spinnerets are very wide apart, cylindrical, longer and more slender than the anterior pair. Under high power one can see spinning tubes on the terminal joint of the left posterior spinneret. At the base the posterior spinnerets are separated by the cone-shaped anal tubercle.) The spinnerets are sufficiently visible to permit the statement that they resemble closely those of the paratype 18733.

The palp is with a large terminal joint (Figs. 65 and 66). The tibia has four apophyses two of which are dorsal and close to the base, one prolateral, short and apical, and one retroventral, long and somewhat curved and situated approximately in the middle of the segment. It has three bristles. The basal retrodorsal apophysis is widened toward its end. The cymbium has a pronounced retrolateral angle. The bulb looks very complicated, but its detailed structure cannot be made out. Nevertheless the tibial apophyses and the general appearance of the palp make the recognition of the species both simple and certain.

*Specimen In. 17612 of the Seebohm Bequest.* Plate XLVI, Figs. 429 to 433. Plate XLVII, Fig. 438. The study of this specimen is rather difficult partly on account of the dark color of the amber, partly because of the peculiar shape of the piece. The previous owner polished off a portion of the abdomen, and portions of several legs. Nevertheless the specimen is fairly complete and the species may be easily recognized from the structure of the palp. The total length of the spider may be given only as a sum of two measurements because the abdomen lies at right angles to the carapace, with the petiolus exposed to view. The abdomen itself appears in profile and shows that in life it overhung the carapace. Total length of the spider 5.12 mm. Carapace 2.56 mm. long, 1.80 mm. wide, so much narrowed in front that the eyegroup appears wider than the head, the eyes projecting on both sides. However, when the head is examined from in front, one can see that the eyegroup is in reality narrower than the face. The thoracic groove is longitudinal, ellipsoidal, deep. A straight, longitudinal line is visible at the bottom of the depression. Owing to the position of the spider and the shape of the piece it is not possible to obtain a side-view of the carapace. But in rotating the piece under the microscope one gets the impression that the highest point of the carapace is in the region of the thoracic groove and

that from here on it slopes forward gradually. Total width of eyegroup 0.81 mm. The quadrangle is wider behind than in front in ratio 20:15. Its length cannot be measured. Both rows of eyes are slightly procurved, the posterior row somewhat more so than the anterior row. Measured in side-view—the only position in which the eyes of this specimen can be measured—the ratio of eyes is AME:ALE:PME:PLE = 7:8:6:9. The AME are separated from each other by  $1/7$  of their diameter, from the ALE by  $5/7$  of their diameter. The lateral eyes are contiguous. The eyes of the second row are almost equidistant, the distance between the PME being very slightly smaller than that between the PME and the PLE. The height of the clypeus cannot be measured.

The chelicerae are fairly long and slender. The margins are oblique. The promargin is smooth, with a scopula. The retro-margin is armed with three teeth, but a scopula is wanting. A boss seems to be wanting. The fangs are short, stout and more or less evenly curved. In strong transmitted light the poison duct is visible in each fang. In the basal two-thirds of the fang the duct is fairly stout, then becomes very fine and opens on the ventral surface of the fang, a little behind its end. The ducts cannot be followed into the basal joint of the chelicerae, nor are the poison glands preserved.

The maxillae are slightly inclined over the lip. The latter is longer than wide at base. The widest region of the lip is near its middle. The lip has therefore the shape of a pentagon with rounded angles.

The sternum is almost circular, fairly convex. The first pair of coxae are very wide apart, the fourth pair contiguous.

Leg formula	$\frac{1}{3.3}$	$\frac{2}{3.2}$	$\frac{4}{3.1}$	$\frac{3}{2.8}$
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	Femur	Pat. + Tib.	Metat.	Tarsus	Total
I	2.40	2.75	2.20	1.20	8.55
II	2.32	2.60	2.20(?)	0.96	8.08
III	2.08	2.28	1.84	0.84	7.04
IV	2.28	2.60(?)	2.20(?)	0.96	8.04

First and fourth femora slightly sigmoid. Second left metatarsus incomplete and second right leg polished off by previous owner at the tibio-metatarsal joint. The length of the second



metatarsus, as given above, is an approximate one. Similarly, the length of the fourth tibia and metatarsus are approximations, because of the poor preservation of the fourth legs.

*Spines.* First leg. Femur dorsal 0-1-0, prolateral 0-0-1, retrolateral 0-0-1, ventral 0. Patella 0. Tibia dorsal 0-1-0, prolateral 1-1, retrolateral 0-1-0, ventral 1-1 (these ventral spines seem to be median in position). Metatarsus dorsal 1-0-1, prolateral 1-1-1, retrolateral 1-1-1, ventral 1-1-2. (The apical verticellum is therefore composed of five spines one of which is dorsal, one prolateral, one retrolateral and two ventral.) All metatarsal spines are very long and slender. Second leg same as first. Third leg. Femur dorsal 0-0-1, prolateral ?, retrolateral 0-0-1, ventral 0. Patella retrolateral 1, elsewhere 0. Tibia dorsal 0, prolateral 1-1, retrolateral ?, ventral 1-1. Metatarsus dorsal 1-0-1, prolateral 1-1-1, retrolateral 1-1-1, ventral 2-2-2. Fourth leg not in good condition. However, the calamistrum is visible and occupies two-thirds of the metatarsus.

The legs are sparsely clothed with simple, rather long hair. In some places as on the ventral surface of the femora it stands at right angles to the segment and may be easily mistaken for trichobothria. Whether true trichobothria are present on tibiae, metatarsi and tarsi cannot be stated with certainty. The view is obstructed by reflections due to the shape of the amber and by the common hair which probably is as long as the trichobothria. Clawtufts are wanting. The upper claws seem to be similar, bent in middle and supplied with five teeth increasing in length distally. The third claw is bent almost at right angles and has a single, long, curved tooth. Unusually stout bristles are present above and below the claws.

The abdomen is ovoid, pointed behind. It is clothed with short hair. The spinnerets and the anal tubercle are plainly visible. The tubercle is shorter than the spinnerets, cone-shaped, with distinct transverse striations which may be remnants of segmentation. The anterior spinnerets are stouter and somewhat shorter than the posterior ones, more or less cylindrical and with a short, hemispherical terminal joint. The posterior spinnerets have a much longer, cone-shaped terminal joint, which is twice as long as the basal joint. The median spinnerets may be plainly seen from below. They are more slender and shorter than the anterior spinnerets. The cribellum is entire. Common spinning tubes are

plainly visible on the terminal joints of the spinnerets. In the posterior pair they occupy the entire inner surface of the terminal joint.

The palpi are difficult to study on account of the dark color of the amber, but their structure is the same as in the type specimen. The femur is approximately as long as the rest of the palp. The tibia has four apophyses, three of which are shown in Fig. 432. One of them is more or less median in position and carries three bristles. Two are more or less prolateral, connected with each other at the base and one of them long and slender. The embolus can be seen only when one studies it through the cymbium in strong transmitted light. It arises somewhat beyond the middle of the bulb, is curved and pointed.

Family *Agalenidae*

Subfamily *Agaleninae*

Genus *Agalena* Walckenaer, 1805

Type *A. labyrinthica* (Clerck).

*Agalena tabida* Koch and Berendt, p. 48, Plate V, Fig. 37.

The description given by Koch is based on a single specimen. Its generic affiliation seems to be correct so far as one may judge from the brief description. The sex is given as female, but the epigynum is neither described nor figured. Only the lengths of the carapace, of the abdomen and of the first leg are given. The species should therefore be considered as inadequately described from the point of view of modern arachnology, but since no other species has been referred by Koch to the Genus *Agalena*, I place the specimen described below in the species *A. tabida*. The specimen in question is immature, presumably a very young spiderling. It is in the Crosby Collection of Cornell University, No. 6. The amber is light colored and almost perfectly clear. It is shown on Plate LXIX, Fig. 620 and Plate LIII, Figs. 493 to 498.

*Pullus*. Total length without spinnerets 1.60 mm. Carapace 0.70 mm. long, 0.75 mm. wide between second and third coxae where it is widest, narrowed down in front to 0.36 mm. Thoracic groove longitudinal. The carapace is comparatively low. Eight eyes in two rows (Fig. 493). Viewed from above the first row is gently procurved. The second row is more strongly procurved and longer than the first. Width of first row 0.24 mm., of second

row 0.31 mm. Ratio of eyes AME:ALE:PME:PLE = 1.25:2:2.5:2. Quadrangle wider behind than in front in ratio 7:4.5, wider than long in ratio 7:6.5. AME separated from each other by not quite two diameters, from the ALE by about the diameter of the AME. Lateral eyes separated by the diameter of the AME. PME separated from each other by two diameters of the AME, from the PLE by 1.25 diameters of the AME. Viewed from in front (Fig. 496) both rows are down-curved. The clypeus is slightly higher than the length of the quadrangle.

Chelicerae relatively long and slender, with basal joint 0.26 mm. long. Margins apparently smooth. Fangs short and pointed.

Maxillae strongly inclined over lip (Fig. 494) which is wider than long. Sternum distinctly convex, widely truncated in front, bluntly pointed between the hind coxae. It is wider than long in ratio 19:17. First coxae very wide apart, fourth coxae separated by twice their width.

$$\text{Leg formula } \frac{4}{\sim 8} \quad \frac{1}{2.6} \quad \frac{2}{2.4} \quad \frac{3}{2.0}$$

	Femur	Pat. + Tib.	Metat.	Tarsus	Total
I	0.50	0.60	0.36	0.38	1.84
II	0.48	0.53	0.31	0.34	1.66
III	0.41	0.41	0.29	0.31	1.42
IV	0.50	0.60	0.38	0.46	1.94

Width of first patella 0.096. First tibial index 16.

Width of fourth patella 0.096. Fourth tibial index 16.

Spines wanting. There are 1-1 fine dorsal bristles on the patella and 1 dorsal bristle on the tibia near base. Three claws. Upper claws bent (Fig. 498), with 6 or 7 long teeth in proximal half, increasing in length distally. Third claw bent at right angles, smooth. The upper claws are similar. Trichobothria few and not typical of the genus. A single long trichobothrium in the middle of the tibia and a single trichobothrium beyond the middle of the metatarsus. No trichobothria on tarsi. No serrated bristles on tarsi. Palpal claw smooth, bent at right angles. The legs are clothed with long, simple hair.

Abdomen ovoid, pointed behind, 0.99 mm. long, 0.74 mm. wide, sparsely clothed with rather long hair. Six spinnerets (Fig. 498). Anterior pair cylindrical, with cone-shaped terminal joint. At base

they are separated by about their width. Median spinnerets much shorter, more slender, cylindrical. Posterior spinnerets longer than anterior spinnerets and their terminal joint is more slender and about half as long as the basal joint. Under high power spinning tubes and a few spigots can be seen on all spinnerets. The anal tubercle is small, cone-shaped, shorter than the basal joint of the posterior spinnerets. A hole in the abdomen makes it impossible to decide whether a colulus was present or is wanting.

Subfamily *Cybaeinae*

Genus *Myro* Cambridge, 1876

Type *M. kerguelensis* Cambridge

I refer with some doubt to this genus two species, *M. hirsutus* and *M. fossilis*, both new. Neither of these species conforms fully with the generic characters given by Cambridge and some of the characters cannot be seen on account of poor preservation. But the lack of these characters and the differences in the others are not sufficient to demand the creation of a new genus.

*Myro hirsutus*, n. sp. Plate LXVII, Fig. 601. Plate XXXII, Figs. 308 to 311. British Museum collection from Samland, In. 18907.

Male. Type. A very poorly preserved specimen in very dark amber of peculiar shape making the study of the characters very difficult even in strong light until one has learned the necessary position of the specimen in reference to the angle of the incident ray and the proper background. The abdomen is so displaced that it lies at right angles to the carapace. The dorsal surface of the latter is obstructed from view by heavy white emulsion which extends also over the abdomen. The ventral surface is clear. Portions of some legs have been polished off by a previous owner.

The total length of the spider can be given only approximately as 4.5 mm. The shape of the carapace cannot be ascertained, and of the eyes only the AME and the right ALE are visible when the specimen is examined from below. The AME seem to be contiguous or nearly so and much smaller than the ALE. The clypeus is high. The chelicerae are stout and distinctly convex in front. Their surface is covered with long, black hair. The maxillae are much wider in front than at the base. They are inclined and meet over the lip. Their anterior edge appears to be transversely truncated and the palp is inserted in the antero-lateral cor-

ner. The lip is triangular, apparently longer than wide at base. The sternum (Fig. 308) is oval, convex, longer than wide, truncated in front. First coxae wide apart, fourth coxae separated by about half their width.

The leg formula cannot be given because it is impossible to measure the carapace. The order of legs is 4123.

	Femur	Pat. + Tib.	Metat.	Tarsus	Total
I	0.95	1.34	0.95	0.57	3.81
II	0.95	1.24	0.75	0.60	3.54
III	0.85	0.95	0.57	0.47	2.84
IV	1.52	1.52	0.85	0.50	4.39

Third and fourth femora distinctly stouter than first and second femora. Spines present only on the two posterior pairs of legs. They are few, but stout. Third leg, Femur 0. Patella retrolateral 1, elsewhere 0. Tibia dorsal 1-1-1, prolateral 1-1, retrolateral 1-1, ventral ?. Metatarsus dorsal 0, prolateral 0-1, retrolateral 1-1, ventral 0. Fourth leg, Femur 0. Patella 0. Tibia ventral 2-2-2 bristles, elsewhere 0. Metatarsus ventral 2-2-2, elsewhere 0.

None of the trochanters are notched. The legs are rather hairy, but all hair is simple. Three claws. The upper claws of the first and second tarsus (Figs. 309 and 310) are dissimilar. The proclaw has a long series of fine teeth, the retroclaw has only six or seven stout teeth. The upper claws of the third and fourth tarsus are similar and resemble the retroclaw which has been just described. The third claw is small and smooth.

The abdomen has the shape of an elongated ellipsoid. It is distinctly hairy. The genital opening is clearly visible. The spinnerets are fairly long, cylindrical. Anterior pair separated by their width, somewhat stouter and longer than the posterior pair. Terminal joint in both pairs cone-shaped, short. Median pair not visible. Colulus wanting. Both palpi well preserved. The left palp is shown in Fig. 311.

*Myro fossilis*, n. sp. Plate LXIV, Fig. 584. Plate XXXVIII, Figs. 360 to 367. British Museum collection from Samland, In. 18115.

Female. Type. A fairly well preserved specimen in rather dark and imperfect amber. Some white emulsion is present on the ventral surface and the previous owner has somewhat damaged

the sternum, but most of the structures are visible. Total length 3.1 mm. Carapace 1.6 mm. long, 1.1 mm. wide between second and third coxae where it is widest. Head rather long (Fig. 365), with almost parallel sides, 0.7 mm. wide. It is clearly set off from the thorax and appears in side-view both somewhat longer and higher than the latter. It rises gradually anteriorly, the highest point being a little behind the eyegroup. There are numerous, irregularly distributed bristles on the head, including a median row of five. The thoracic groove is longitudinal.

Eight eyes in two rows. The full width of the eyegroup is 0.46 mm., the first row being distinctly shorter than the second. Viewed from above the first row is slightly recurved, the second row slightly procurved. Ratio of eyes AME:ALE:PME:PLE = 3:4.5:3.5:4.5. The quadrangle (Figs. 361 and 362) is wider behind than in front in ratio 8:6.5. Its exact length cannot be measured on account of the position of the spider in the amber. The AME are separated from each other by not more than their radius and by the same distance from the ALE. The PME are separated from each other by about their diameter. The lateral eyes are contiguous, situated on a tubercle, prominent. A proper view of the clypeus is impossible owing to reflections. It appears to be no higher than the diameter of the AME.

The chelicerae are rather stout and strong, with small fangs (Fig. 367). The basal joint is 0.7 mm. long. No boss can be seen, neither are the margins visible, but one can discern a thick promarginal scopula coated with dirt.

The maxillae are much wider in front than at the base. Their outer edge is evenly curved and the palp is inserted near the base. The lip is poorly visible, but does not appear to reach the middle of the maxillae.

The sternum (Fig. 360) is convex, very wide in front where it is transversely truncated. Its posterior end is rounded and supplied with three hairs. The first coxae are wide apart, the fourth coxae are separated by about half their width. The sternum is longer than wide in ratio 9:8.

Neither the leg formula nor the order of legs can be given because the previous owner polished off all tarsi and portions of some metatarsi. The length of the complete segments is as follows: First leg. Femur 1.4 mm., Patella with Tibia 1.56 mm., Metatarsus 0.88 mm. Second leg. Femur 1.08 mm., Patella with

Tibia 1.36 mm. Third leg. Femur 0.96 mm., Patella with Tibia 1.28 mm. Fourth leg. Femur 1.08 mm., Patella with Tibia 1.80 mm., Metatarsus 1.80 mm.

The spines are fine and long. First leg. Femur dorsal 1-1-1, prolateral 0-0-1, retrolateral 0, ventral 1 about one-fifth from base. Patella dorsal 1-1-1, elsewhere 0. Tibia dorsal 0, prolateral 1 before middle, retrolateral 0, ventral 1 in middle. Metatarsus dorsal 0, prolateral 0-0-1, retrolateral 0, ventral 2-2-2. Second leg presumably same as the first, but its position is such that the spines cannot be counted. Third leg. Femur dorsal 1-1-0, elsewhere 0. Patella dorsal 1-1-1, the apical spine very long, elsewhere 0. Tibia dorsal 1-1, the basal spine very long, prolateral 0-1, elsewhere 0. Fourth leg. Femur dorsal 1-0, elsewhere 0. Patella dorsal 1-1, elsewhere 0. Tibia dorsal 1-0, prolateral 1-1, retrolateral 0, ventral 0-2. Metatarsus dorsal 1-1, prolateral 1 near middle, retrolateral 1-1, ventral 0.

The legs are rather hairy and the hair being as long as the spines the distribution of the latter given above may be not quite correct. The trichobothria are numerous, in two rows on tibiae and metatarsi.

Abdomen ovoid, 1.6 mm. long, 1.1 mm. wide, clothed with long bristles which give it a hairy appearance. Six spinnerets. Anterior pair cylindrical, separated at base by their width. Posterior pair (Fig. 363) smaller and somewhat more slender, with cone-shaped terminal joint, at the end of which a single spigot is visible. Median pair still smaller and shorter. The posterior spinnerets are separated by the width of the anal tubercle which is comparatively small. A colulus is wanting. The palpi are apparently of the female type, but the terminal joint has been cut in half by the previous owner. There are stout bristles on the patella and tibia.

Family *Pisauridae*  
Subfamily *Thaumasinae*  
Genus *Esuritor*, nov.

Closely related to *Voraptus* Simon from which it may be separated by the much smaller size of the AME. The characters of the genus may be given as follows:

Carapace low. Head on the same level with thorax. Eyegroup as wide as the head. Both rows of eyes recurved, those of the

second row considerably larger than the eyes of the first row. Clypeus low. Chelicerae with boss. Lip longer than wide. Sternum convex. First coxae wide apart. Fourth coxae separated by about half their width. Trochanters slightly notched. Ventral spines on anterior tibiae and metatarsi very long. Trichobothria numerous and long, in two rows on tibiae, metatarsi and tarsi, increasing in length distally. Onychium, claw-tufts and serrated bristles wanting. Upper claws similar, pectinated in a single row. Third claw smooth and small. Six cylindrical spinnerets. (Derivation of name: Latin, *esuritor*—a hungry person.) Type *E. spinipes* n. sp.

*Esuritor spinipes* n. sp. Plate VIII, Figs. 69 to 72. Plate LVIII, Figs. 534 and 535.

British Museum, coll. Klebs 503, No. 13401, In. 18745. Type.

British Museum, coll. Klebs 476, No. 13400, In. 18718. Paratype.

Type. Immature female. The specimen, on removal from the glass cell, was found to have an engraving XIII B401, which had to be polished off to obtain a clear view of the spider from that side. Total length 5.0 mm. Carapace 2.6 mm. long, 1.28 mm. wide in the region of the eyes, 2.0 mm. wide between second and third coxae where it is widest. The carapace is flat. The head is on the same level with the thoracic portion. The posterior declivity is gentle and covered up by the abdomen. Thoracic groove longitudinal, long and deep. Between the thoracic groove and the eyes a few bristles are present. The rest of the carapace is clothed with recumbent hair. The eyegroup is as wide as the head. Lateral eyes on each side on a common tubercle, but the ALE are not visible from above. Both rows strongly recurved. First row shorter than second row. Quadrangle wider behind than in front in ratio 25:18, wider than long in ratio 25:21. Ratio of eyes AME: ALE: PME: PLE: = 8:8:13:13, but this ratio may be not quite correct because of the difficulty of getting the correct view for measurement. (The ratio given for the Paratype is probably nearer the truth.) The AME are separated by their radius and by the same distance from the ALE. The full width of the first row is 0.89 mm. The PME are separated from each other by one-sixth of their diameter and from the PLE by three-quarters of their diameter. The full width of the second row is 1.24 mm.



The clypeus is equal to the diameter of the AME. It is vertical, with stout bristles which are directed forward. The sides of the head are almost vertical.

Chelicerae powerful, with strong boss. Outer edges parallel, inner edges diverging. Anterior surface with stout bristles. Basal joint 1.0 mm. long. Margins oblique, but neither their armature, nor the fang can be seen in any position of the specimen.

Lip and sternum cannot be measured. As far as one can judge by appearances the lip is longer than wide and the sternum, which is distinctly convex and clothed with erect bristles, is very slightly longer than wide. First coxae wide apart, fourth coxae separated by about half their width. All trochanters are slightly notched.

Leg formula	4	1	3	2
	3.3	2.9	2.8	2.8

	Femur	Pat. + Tib.	Metat.	Tarsus	Total
I	2.20	2.94	1.42	0.88	7.44
II	2.20	2.94	1.33	0.80	7.27
III	2.20	2.72	1.56	0.90	7.38
IV	2.40	3.00	2.20	1.10	8.70

The legs are clothed with simple, long, brown hair. The ventral spines of the tibia and metatarsus (Fig. 69) of the first and second pair of legs are very long.

*Spines.* First leg. Femur dorsal 1-1-1, the first and third very small spines, the middle one a long bristle, prolateral 0-1-0. (This spine sits on a distinct pedestal in the middle of the segment, is directed forward and downward at 45° and is almost half as long as the femur.) Elsewhere 0. Patella dorsal 0-1 apical bristle, elsewhere 0. Tibia dorsal 0, prolateral 0-1-1, retrolateral 1-1-0, ventral 2-2-2-2 long spines (first pair near base and longest, fourth pair one-third from end. End of second pair reaches base of fourth pair). Metatarsus ventral 2-2-2 long spines (first pair near base, third pair apical. Tip of first pair reaches base of third pair). Elsewhere 0.

Second leg same as first except that the prolateral spine on the femur is quite small.

Third leg. Femur dorsal 1-1-1, prolateral 0-1-1, retrolateral 0-0-1, ventral 0. Patella dorsal 1-1 bristles, prolateral 0, retrolateral 1 bristle, ventral 0. Tibia dorsal 0, prolateral 0-1, retrolateral 0-1,

ventral 0-2-2, the apical pair quite small. Metatarsus dorsal 0, prolateral 0-0-1, retrolateral 0-0-1, ventral 2-2-2.

Fourth leg same as third.

Trichobothria numerous, in two rows on tibiae, metatarsi and tarsi, increasing in length distally. The trichobothria are quite long, especially on the first and second pair of legs. The distal metatarsal trichobothrium is here almost as long as the metatarsus itself.

Onychium wanting. Three claws. Upper claws similar (Fig. 72), curved, with a single row of from 6 to 9 teeth. Third claw small, bent in middle, smooth. Claw tufts and serrated bristles wanting. Palp with a claw of the same type as the upper claws on the tarsi. All hair simple.

Abdomen elongated, 2.5 mm. long, 1.7 mm. wide, sparsely clothed above with stiff, long bristles. The sides are clothed still thicker with similar bristles. The ventral surface is covered with white emulsion.

*Paratype.* Plate LVIII, Fig. 534. Plate VIII, Figs. 69 and 72.

This specimen is still younger than the type and measures only 4.2 mm. in length. The eyeratio is AME: ALE: PME: PLE = 6: 5: 10: 12. Their disposition is the same as in the type, as are all other characters. The ventral surface of the abdomen is clothed with comparatively short, brown hair. The anterior spinnerets are contiguous and a colulus is visible between them. The posterior spinnerets are slightly longer than the anterior ones and have a cone-shaped terminal joint.

#### Family *Insecutoridae*, nov.

The heart and the tracheal system of this new fossil family of spiders are characters which probably will remain forever unknown unless recent representatives should be discovered. Nevertheless I place this family in the Branch *Trionychae* of the Suborder *Dipneumonomorphae*, because the presence of a single pair of lungs is quite certain, as is the number of tarsal claws. Under the circumstances the choice would be either between the Branch *Trionychae* or Branch *Quadrostiatae*. It happens, however, that the *Insecutoridae* have a great deal in common with the *Pisauridae* and very little in common with the quadrostiate families with three claws. The tracheal spiracle is practically never visible in

amber spiders, so that the final choice has to be made on the strength of other characters. The question may be raised why a new family has to be established. Were it not better to include the new genus in some already known family, such as the *Pisauridae*, at the worst as a new subfamily? Unfortunately the three species placed in the new family exhibit characters which make this not only not desirable, but quite impossible, unless, indeed, the characters of well established families were so revised and broadened as to accommodate the new fossil genus. That fossil genus exhibits characters found in recent *Pisauridae*, *Agalenidae* and *Argiopidae*, yet does not fit into any of them. A similar difficulty was encountered by me in 1925 when I described a recent spider from Panama under the name of *Mimicosa spinosa*. In that case the preponderance of characters in common between *Mimicosa* and *Argiopidae* decided me to place that then new genus into the latter family, although the spider had characters found in *Pisauridae* and *Lycosidae*. In the case of the Genus *Insecutor* the safest method seems to me to be the creation of the new Family *Insecutoridae*.

Characters of the Family. Chelicerae diaxial. Two lungs. Cribellum and calamistrum wanting. Colulus wanting. Six spinnerets, anterior pair stouter and longer than posterior pair. Anal tubercle two-jointed, with bristles. Claw-tufts, serrated bristles and pedal scopulae wanting. Legs fairly slender, with long spines standing almost at right angles. Hair simple. Trichobothria numerous, in two rows on tibiae, in one row on metatarsi and tarsi. Chelicerae parallel, with strong boss and smooth, oblique margins. Maxillae parallel. Lip not thickened at end. Sternum very widely truncated in front, pointed behind. First coxae wide apart, hind coxae separated by the end of the sternum. None of the trochanters notched. Carapace narrowed in front. Eight eyes in two rows. Three claws. Upper claws pectinate in a single row.

#### Genus *Insecutor*, nov.

With the characters of the family. Anterior median eyes smallest. Quadrangle wider behind than in front. Thoracic groove longitudinal. Upper claws dissimilar, proclaw with about twice the number of teeth as the retroclaw. Type *I. aculeatus* n. sp. (Derivation of name: Latin—*Insecutor*—a pursuer.)

## Key to species

1. Order of legs 1234. *I. rufus* n. sp.
- \* Order of legs 2143 ..... 2
2. Promarginal scopula composed of a row of long and stout bristles, the one nearest the fang by far the longest and stoutest. Proximal half of chelicerae with long, obliquely directed bristles crossing similar bristles of the opposite side ..... *I. mandibulatus* n. sp.
- \* Promarginal scopula not conspicuous. *I. aculeatus* n. sp.

*Insecutor aculeatus* n. sp. Plate LXI, Figs. 560 and 564. Plate XX, Figs. 186 to 192. Plate XXVI, Figs. 246 and 247. Plate XXVII, Fig. 251.

Two specimens in the collection of the British Museum:

- a) Type. In. 18741, Klebs 499, No. 13465,
- b) Paratype. In. 18723, Klebs 480, No. 13447.

*Type.* Immature female. Figs. 186 to 192 and 560. Well preserved in clear amber. Abdomen partly coated with white emulsion. The piece is full of air-bubbles on the underside. Color of chitin black, lighter in spots.

Total length 3.2 mm. Carapace (Fig. 186) 1.4 mm. long, 1.15 mm. wide between second and third coxae where it is widest, narrowed gradually anteriorly to the width of the eyegroup, which is 0.58 mm. Thoracic groove longitudinal, deep. The cephalothoracic sulci delimit the head clearly. The thoracic groove extends posteriorly to the posterior declivity and its end is hidden by the abdomen. On each side of the thoracic groove the carapace forms a rounded hump indicated in the figure by the curves. They form the highest portion of the carapace which, generally speaking, is rather flat and slopes forward gradually while its posterior declivity is steep. A median crest of fine, long bristles directed forward runs from the dorsal groove to the eyegroup.

Eight eyes in two rows (Fig. 187). Anterior row very slightly recurved, posterior row slightly procurved and longer. Quadrange wider behind than in front in ratio 11.5:9, as long as wide behind. Lateral eyes, although clearly separated from each other are nevertheless situated on a common tubercle. In reality the width of the eyegroup is smaller than the width of the head. If the spider is so placed under the microscope that the quadrangle is horizontal,

the eyegroup measures only 0.58 mm. as given above, but the width of the head in a straight line from one ventrolateral margin to the other is 0.72 mm. Ratio of eyes AME:ALE:PME:PLE = 2.5:3.0:3.5:3.5. The AME are separated from each other by  $4/2.5$  of their diameter and from the ALE by  $3/2.5$  of their diameter. The PME are separated from each other by  $5/2.5$  of the diameter of the AME and from the PLE by the same distance. The lateral eyes are separated by  $3/2.5$  of the diameter of the AME, or what is the same by the diameter of the ALE. The clypeus is vertical, equal to  $4/2.5$  of the diameter of the AME, *i. e.* almost one and three-quarters of their diameter.

The chelicerae are parallel. The boss is not visible, neither is it possible to see the margins. The maxillae are as long as the chelicerae and are placed with the lip at right angles to the sternum. Thus the chelicerae and maxillae are directed almost vertically downward when the spider is in its normal position on the ground. The palpi are inserted near the base of the maxillae (Fig. 188). The lip is wider than long in ratio 8:6, reaches the middle of the maxillae, is not rebordered, but slightly emarginate and has four small bristles at its anterior end.

The sternum (Fig. 189) is longer than wide in ratio 11:8, slightly convex, truncated in front, produced behind between the hind coxae. First coxae wide apart. Fourth coxae separated by about half their width. None of the trochanters are notched.

Leg formula	2	1	4	3
	4.1	3.9	3.7	3.5

	Femur	Pat. + Tib.	Metat.	Tarsus	Total
I	1.44	1.84	1.40	0.80	5.48
II	1.56	1.88	1.44	0.84	5.72
III	1.32	1.60	1.24	0.68	4.84
IV	1.40	1.60	1.44	0.72	5.16

Width of first patella 0.192. First tibial index 10.4.

The legs are fairly slender and long. They are clothed with very short, spinose hair. Some considerably longer hair is present on the ventral surface of the femora near the end of the joint. Scopulae are wanting on all legs. Serrated bristles are also wanting. The spines are long and fine and stand at almost right angles to the leg, calling immediate attention to themselves. (Fig. 191.)

*Spines.* First leg. Femur dorsal 1-1-1, the apical spine very

small, prolateral 0-1-1, the apical spine half as long as the preceding one, retrolateral 1-1-1, the apical spine small, ventral a row of 4 or 5 long bristles. Patella, dorsal 1-1, elsewhere 0. Tibia dorsal 1-1p-1, prolateral 1-1, retrolateral 0-1, ventral 2-2-0. Metatarsus dorsal 1-1-1, prolateral 0-1-1, retrolateral 1-1-1, ventral 2-2-2.

Second leg same as first.

Third leg. Femur dorsal 1-1-1, apical spine very small, prolateral 0-1, retrolateral 0-1, ventral four or five fine bristles. Patella, dorsal 1-1, elsewhere 0. Tibia, dorsal 1-1, prolateral 1-1, retrolateral 1-1, ventral 2-2-0. Metatarsus dorsal 1-1-1, prolateral 1-1-1, retrolateral 1-1-1, ventral 2-2-2.

Fourth leg same as third.

Three claws. Upper claws dissimilar, curved, pectinated in a single row. Proclaw with about 12 fine teeth, retroclaw with 6 teeth. Third claw (Fig. 192) bent, with a single tooth. Claw-tufts wanting.

Trichobothria numerous, fine and long, in two rows on tibiae, in one row on metatarsi and tarsi. In addition to the trichobothria there are peculiar short hairs standing almost at right angles to the leg. On the third metatarsus and tarsus are also erect hairs which are, however, bent in such a manner as to give the appearance of hooks the ends of which are directed backwards.

The abdomen is ovoid, pointed behind, slightly flattened above. It is 1.7 mm. long, 1.0 mm. wide in middle. There are distinct pliations at the posterior end of the abdomen, running transversely on the dorsal surface, then turning almost at right angles and running longitudinally on the sides of the abdomen. The abdomen is clothed with bristles of variable length and stoutness, irregularly distributed. The anal tubercle is cone-shaped, two jointed, with stiff bristles. The spinnerets are visible through the emulsion with which they are covered. The anterior pair is considerably stouter and appreciably longer than the posterior pair. The median pair is not visible.

The palpi are with long and fine spines. There are two dorsal spines on the femur, two on the patella and some on the tibia and on the terminal joint, but the number of these cannot be determined because of the position of the palpi. A slender claw is present.

The spider seems to have been injured in life. There is a globule of some substance adhering to the base of the left

chelicera. It may have been blood which oozed out when the spider became entangled in the gum.

*Paratype.* Figs. 246, 247, 251 and 564.

An immature or possibly a mature female well preserved in clear amber which unfortunately has a very peculiar shape, two large air-bubbles on the ventral surface and dirt around the mouth. The abdomen is coated with a heavy sheet of white emulsion through which the bristles protrude. It is placed at right angles to the carapace and its ventral surface is covered over by the left femora. The appearance is that of a laterigrade spider, and it is possible that in life the spider was capable of laterigrade locomotion just as many recent representatives of the Family *Pisauridae* are able to run sideways swiftly, although the family as such is not considered to be laterigrade. The color of the chitin is light rufous, that of the abdomen almost light yellow.

Total length measured as the sum of the carapace and abdomen is 4.5 mm. But since the abdomen in life must have been overhanging the carapace the total length was probably not more than 4.2 mm. Carapace 1.8 mm. long, 1.6 mm. wide between second and third coxae where it is widest, narrowed down anteriorly to the width of the eyegroup which is 0.64 mm. Thoracic groove longitudinal, deep, extending to the beginning of the last third of the thoracic portion of the carapace. On each side of the groove the carapace forms a rounded shoulder hump. The cephalothoracic sulci delimit the head sharply. A median crest of fine bristles runs from the anterior edge of the thoracic groove to the eyegroup. From the shoulders forward the carapace slopes gradually toward the eyes. The posterior declivity is steep.

Eight eyes in two rows (Fig. 247). Viewed from above the first row is so slightly procurved that it almost gives the impression of a straight line. The posterior row is distinctly procurved and slightly longer than the anterior row. The AME are the smallest. The quadrangle is wider behind than in front in ratio 12:10 and about as long as wide behind. The lateral eyes are on a common tubercle on each side of the head, but clearly separated from each other by almost, though not quite their diameter. Ratio of eyes AME:ALE:PME:PLE = 3:5:4:5. The AME are separated from each other by a little more than their diameter. The clypeus is equal to two diameters of the AME.

The view of the mouthparts and of a portion of the sternum is

obstructed by dirt, white emulsion and air-bubbles. Enough, however, is visible of the sternum to say that it is of the same appearance as in the type. It is slightly convex, shield-shaped, produced behind between the fourth coxae. The chelicerae are also partly visible. They are fairly long, with a strong boss, parallel sides and short fang. Their anterior surface is clothed with short bristles.

First coxae wide apart. Fourth coxae separated by half their width. None of the trochanters are notched. The legs are fairly long, slender and spinose, the spines also long, slender and standing almost at right angles to the segment. Scopulae are wanting on all legs. The hair is simple as in the type and the curved hairs are also as in the type, on third metatarsus and tarsus. Trichobothria as in type.

Leg formula	2	1	4	3
	4.0	3.8	3.5	3.4

	Femur	Pat. + Tib.	Metat.	Tarsus	Total
I	1.80	2.28	1.72	0.96	6.76
II	1.96	2.40	1.80	1.00	7.16
III	1.72	2.08	1.52	0.80	6.12
IV	1.80	2.08	1.60	0.80	6.28

Width of first patella 0.260. First tibial index 11.4.

*Spines.* First leg. Femur dorsal 1-1-1, last spine small, prolateral 0-1-1, elsewhere 0. Patella dorsal 1-1, apical spine very long, elsewhere 0. Tibia dorsal 1-1, prolateral 1-0, retrolateral 1-1, ventral 2-2-0. Metatarsus dorsal 0-1 apical, prolateral 1-1-2, retrolateral 1-1-1, ventral 2-2-2 (thus an apical verticellum of 6 spines is formed).

Second leg same as first except: Femur prolateral 0-0-1, retrolateral 0-0-1. Tibia prolateral 1-1. Metatarsus dorsal 0, retrolateral 1-1-2 (the apical verticellum is therefore also composed of six spines, but arranged somewhat differently from the verticellum of the first leg).

Third leg. Femur dorsal 1-1-1, apical spine very short, prolateral 0-0-1, retrolateral 0-0-1, ventral 0. Patella dorsal 1-1, apical spine very long, elsewhere 0. Tibia dorsal 1-1, prolateral 1-1, retrolateral 1-1, ventral 1p-2. Metatarsus dorsal 0, prolateral 1-1-2, retrolateral 1-1-2, ventral 2-2-0 (making an apical verticellum of 4 spines).



Fourth leg same as third.

Three claws. Upper claws dissimilar, proclaw with about twice as many teeth as retroclaw. Third claw with a single, strongly curved tooth. Palpal claw (Fig. 246) with a row of very fine teeth.

Abdomen ovoid, slightly depressed above, pointed posteriorly, 2.7 mm. long, 1.7 mm. wide in middle. Anal tubercle (Fig. 251) cone-shaped, rather long, with a few hairs at the end. Anterior spinnerets stouter and longer than the posterior pair which is separated by the anal tubercle. The anterior pair is contiguous. A colulus is wanting. Median spinnerets not visible.

All hair of the simple type.

*Insecutor mandibulatus* n. sp. Plate XXVI, Figs. 238 to 245, and 248. Plate XXVII, Figs. 249 and 250. Plate LX, Fig. 559. Plate LXI, Fig. 563, and Plate LXVI, Fig. 599.

Of this species the British Museum has five specimens:

- a) In. 18742, Klebs 500, No. 13456, Type.
- b) In. 18721, Klebs 478, No. 13434, Paratype.
- c) In. 18725, Klebs 482, No. 3775.
- d) In. 17574, Seeböhm's Bequest. A poor, but typical specimen.
- e) In. 17563, Old Collection. A very poor specimen, much larger than the type, in very dark amber which is full of reflections.

Type. Female. Plate LXVI, Fig. 599 and Plate XXVI, Figs. 238 to 245.

The amber in which the specimen is enclosed was originally so cut that it presented only five imperfect and poorly polished surfaces. Of the abdomen only the ventral portion of the anterior half was left. Dirt in the amber obstructed clear view. It was necessary to cut the piece anew and to give it a high polish. One of the surfaces had an original engraving XIII B456 which had to be polished off. Color of the chitin: chelicerae black, carapace and anterior two pairs of legs dark brown, posterior two pairs slightly lighter, sternum rufous, abdomen practically colorless.

Total length can be given only approximately on the assumption that the abdomen was more or less oval. Including the chelicerae the total length comes then to about 5.0 mm. Carapace 2.1 mm. long, 1.72 mm. wide between the second and third coxae where it is widest. It is considerably narrowed anteriorly (Fig. 240).

Thoracic portion almost circular, while the head has fairly parallel sides. Dirt prevents the measurement of its width in a dorsal view. In face view (Fig. 238) the width is 0.80 mm. and the eyegroup is somewhat narrower. The cephalothoracic sulci clearly delimit the head. The thoracic groove is longitudinal, deep. On the sides of the thoracic groove the carapace forms rounded shoulder humps shown in Fig. 239. The thorax is somewhat higher than the head, but not much so, and when viewed in profile the head appears distinctly curved. The posterior declivity is steep.

Eight eyes in two rows, difficult to see. The AME are smaller than the others and when viewed from in front appear to be each on a prominent tubercle. The lateral eyes on each side of the head are on a common tubercle, subcontiguous and separated from the AME by about the diameter of the latter. The PME are still more difficult to see because they are not elevated over the surface of the head on any tubercle. Viewed from in front the first row is almost straight, barely perceptibly downcurved, the second row slightly, but distinctly downcurved.

The chelicerae are fairly long, slender, with parallel outer edges. Basal joint 1.0 mm. long. The inner edges of the chelicerae are distinctly diverging as shown in Fig. 238. The margins are visible only in a certain direction of the illuminating beam of light and appear then to be oblique. The promargin has a scopula of long, stout bristles, the one nearest the fang particularly stout and long. They are brown in color. No teeth are present on the margins. From the middle of the proximal portion of the chelicerae, not far from the inner edge there arise long bristles forming a row and crossing with the bristles of the opposite side. The fangs are held open and are therefore plainly visible. They are short, with a little swelling on the inner edge two-fifths from base and a rather fine, evenly curved end.

Neither the maxillae, nor the lip can be seen.

The sternum (Fig. 241) is widely truncated in front, produced to a point between the hind coxae. It is slightly convex, longer than wide in ratio 10:9. The first coxae are wide apart, the fourth coxae are separated almost by their width. None of the trochanters are notched. The legs are rather slender, long and spinose. The spines are numerous, very long and standing almost at right angles to the leg.

Leg formula	2	1	4	3	
	4.5	4.3	4.0	3.9	
	Femur	Pat. + Tib.	Metat.	Tarsus	Total
I	2.40	3.20	2.40	1.08	9.08
II	2.60	3.20	2.40	1.16	9.36
III	2.28	2.68	2.20	0.96	8.12
IV	2.40	2.68	2.28	1.04	8.40

Width of second patella 0.312. Second tibial index 9.7.

Width of fourth patella 0.240. Fourth tibial index 8.9.

*Spines.* First leg. Femur dorsal 1-1-1, the apical spine short, prolateral 1 beyond middle, retrolateral 0, ventral 1-1-1-1, long, erect bristles. Patella dorsal 1-1, the distal spine longer than the segment, elsewhere 0. Tibia dorsal 1-0-1, prolateral 1-1-1, retrolateral 1-1, ventral 2-2-2. Metatarsus dorsal 0, prolateral 1-1-1, retrolateral 1-1-1, ventral 2-2-2.

Second leg same as first.

Third leg. Femur dorsal 1-1-0, prolateral 0-0-1, retrolateral 0-0-1, ventral an irregular row of bristles. Patella dorsal 1-1, the distal spine longer than the segment, retrolateral 1 short spine, elsewhere 0. Tibia dorsal 0-1, prolateral 0-1, retrolateral 1-1, ventral 2-2-2, the apical pair small. Metatarsus dorsal 1-1-0, prolateral 1-1-1, retrolateral 1-1-1, ventral 2-2-2.

Fourth leg same as third.

Three claws. Upper claws dissimilar, curved. Proclaw with a series of 10-12 teeth, retroclaw with 6 teeth (Figs. 243, 244). Third claw with a single, long, curved tooth. Claw tufts wanting, but very finely serrated bristles present both below and above the claws. Legs clothed with simple, short hair. Some hair on tarsi stands at right angles to the segment. No trichobothria can be seen.

Palpi with long bristles on all joints. Terminal joint with a claw.

As stated above only a portion of the abdomen is left. It is sparsely clothed with very short, erect hair. The pair of lung-slits are visible, but the genital fold is not apparent. This circumstance speaks in favor of the assumption that the specimen is an immature female. The outline of both lungs may be followed without difficulty. The sides of the abdomen are clothed with very short hair, while on the back long bristles are present.

*Paratype.* Female. Plate LX, Fig. 559, Plate XXVI, Fig. 248, Plate XXVII, Figs. 249, 250.

A rather poorly preserved specimen in clear, but dark amber the peculiar shape of which makes examination of some structures difficult. Some white emulsion is present around the mouthparts. The color of the chitin is generally light yellow, darker in spots.

Total length 4.3 mm. Carapace 2.68 mm. long, 1.58 mm. wide between second and third coxae where it is widest, narrowed anteriorly almost to the width of the eyegroup. Thoracic groove longitudinal, deep. General shape of the carapace and head same as in type. Eyes in two rows (Fig. 248). First row slightly procurved, second row a little more so and slightly longer than the first row. Its full width is 0.68 mm. Quadrangle wider behind than in front in ratio 12:10, as long as wide behind. Lateral eyes subcontiguous, on a common tubercle. Ratio of eyes AME:ALE:PME:PLE=4:6:5:6. Clypeus equal to two diameters of the AME. Chelicerae fairly long, with parallel outside edges and oblique margins. Promargin with a scopula formed by a row of six or seven long bristles, the one nearest the fang by far the stoutest. Retromargin not visible. Lip and maxillae may be seen through the emulsion (Fig. 249). The lip reaches the middle of the maxillae. Sternum widely truncated in front, produced to a point between the hind coxae. First coxae wide apart, fourth coxae separated by half their width. None of the trochanters are notched.

Leg formula	2	1	4	3	
	2.7	2.6	2.4	2.3	
	Femur	Pat. + Tib.	Metat.	Tarsus	Total
I	1.88	2.40	1.76	0.96	7.00
II	2.00	2.48	1.88	1.00	7.36
III	1.68	2.08	1.60	0.72	6.08
IV	1.76	2.12	1.72	0.72	6.32

Spines long and numerous, standing at almost right angles to the leg.

*Spines.* First leg. Femur dorsal 1-1-1, apical spine small, prolateral 0-0-1, retrolateral 0-0-1, ventral a row of five long bristles. Patella dorsal 1-1, apical spine very long, elsewhere 0. Tibia dorsal 1-1, prolateral 1-1, retrolateral 1-1, ventral 2-2-1. Metatarsus dorsal 1-0, prolateral 1-1-2, retrolateral 1-1-2, ventral 2-2-1 (thus an apical verticellum of five spines is formed).

Second leg same as first, except: Patella retrolateral 1 small spine.

Third leg. Femur dorsal 1-1-1, apical spine small, prolateral 0-0-1, retrolateral 0-0-1, ventral two rows of bristles. Patella dorsal 1-1, apical spine very long, retrolateral 1 small bristle, elsewhere 0. Tibia dorsal 1-1, prolateral 1-1, retrolateral 1-1, ventral 2-2-2. Metatarsus dorsal 0-1-1, prolateral 1-1-2, retrolateral 1-1-2 ventral 2-2-1 (thus an apical verticellum of six spines is formed).

Fourth leg same as third, except: Femur ventral a single row of small bristles. Tibia ventral 1p-1p-2.

Palp. Femur dorsal 1-1-1, prolateral 1 distal bristle, elsewhere 0. Patella dorsal 1-1, apical spine very long, retrolateral 1 small bristle, elsewhere 0. Tibia dorsal 1-1, prolateral 1-0, elsewhere 0. Terminal joint dorsal 1-1, prolateral 1-1-1, diminishing in length distally, retrolateral 1-0-1, ventral several small spines the number of which is not certain. There is a claw present at the end of the terminal joint, but its structure cannot be seen.

Three claws. Upper claws dissimilar, of the same appearance as in type.

Abdomen ovoid, pointed behind, 2.5 mm. long, 1.7 mm. wide in middle. Anal tubercle cone-shaped, prominent, two-jointed, clothed with bristles. Anterior spinnerets (Fig. 250) stouter and longer than posterior spinnerets, with rounded terminal joint. They are almost contiguous at base and a colulus is wanting. Posterior spinnerets more slender, far apart, with rounded terminal joint.

The ventral body wall is so transparent that the genital fold is barely visible and nothing can be said about the epigynum.

Specimen In. 18725, Fig. 563, is 3.6 mm. long. Carapace 2.0 mm. long, 1.6 mm. wide. Width of eyegroup 0.72 mm. It is presumably an immature female and in its characters corresponds closely with the type.

*Insecutor rufus* n. sp. Plate XXXIX, Figs. 372 to 378. Plate LXVI, Fig. 600.

Type. British Museum collection from Samland, In. 18123. Female. A fairly well preserved specimen in clear amber which is much darker in the immediate vicinity of the spider. An oblique plane of cleavage makes observation from certain directions impossible. The previous owner polished off the first, second and third legs of the right side leaving only portions of their femora, but fortunately the legs of the left side are all complete. The color of the chitin is light rufous.

Total length with spinnerets 2.64 mm. Carapace 1.24 mm. long, 0.88 mm. wide between second and third coxae where it is widest, narrowed down anteriorly to the width of the eyegroup which is 0.48 mm. Highest point at thoracic groove which is longitudinal, very fine. (Figs. 372, 373.) From here on the carapace slopes gently forward. The posterior declivity is rather steep. Shoulder humps, characteristic of the two preceding species, seem to be wanting, but the point is difficult to decide because the cephalothorax is filled with a large bubble of air making observation difficult. The height of the carapace at its highest point is 0.4 mm.

Eight eyes in two rows. AME smaller than the other eyes. Lateral eyes on a common tubercle. The clypeus is concave, higher than the diameter of the AME, but lower than the quadrangle. Exact measurements of eyes are not possible on account of reflections.

The chelicerae are powerful, slightly geniculated at base. Basal joint 0.5 mm. long. The margins are oblique. Promargin smooth, with a scanty scopula of a few bristles (Fig. 376). Retromargin not visible. Fang short. Maxillae are difficult to study and still more difficult to figure in correct proportions. They reach the end of the chelicerae and are slightly inclined over the lip, wider in front than at base. The palp is inserted near the base of the maxillae. The lip is wider than long, with a slightly procurved base.

The sternum (Fig. 375) is very wide in front, bluntly pointed between the hind coxae, convex and but little longer than wide. First coxae very wide apart. Fourth coxae separated by almost their width. None of the trochanters are notched.

Leg formula	1 3.5	2 3.3	3 3.1	4 2.8
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	Femur	Pat. + Tib.	Metat.	Tarsus	Total
I	1.08	1.40	1.00	0.80	4.28
II	1.08	1.40	1.00	0.56	4.04
III	1.00	1.40	0.96	0.52	3.88
IV	1.00	1.00	0.84	0.60	3.44

*Spines*, long and numerous, standing almost at right angles. First leg. Femur dorsal 1-1-1, apical spine small, prolateral 0-1-1, retrolateral 0-0-1, ventral 0. Patella dorsal 1-1, elsewhere 0. Tibia dorsal 1-1-1, prolateral 1-1-1, retrolateral 1-1-0, ventral 2-2-2.

Metatarsus dorsal 0-1-1, prolateral 0-1-1, retrolateral 1-1-1, ventral 1-p-2-2 (thus an apical verticellum of five spines is formed).

Second leg same as first.

Third and fourth legs are difficult to study on account of their position.

Three claws (Fig. 374). Upper claws dissimilar, distinctly bent, pectinate in a single row. The number of teeth is difficult to count, but there are about 12 teeth on the proclaw and half as many on the retroclaw. Third claw bent, with a single, very small tooth. Claw tufts wanting. Finely serrated bristles present at the end of the tarsus.

Trichobothria seem to be in a single row on tibiae, metatarsi and tarsi. The legs are clothed with simple hair having the appearance of fine bristles.

Palpi with many long spines distributed as follows: Femur dorsal 1-1-1, elsewhere 0. Patella dorsal 1-1, the apical spine very long and stout, curved and extending to the end of the tibia. Elsewhere 0. Tibia dorsal 1-1, retrolateral 1-0, elsewhere 0. Terminal joint dorsal 2-0, prolateral 1-1, retrolateral 1-1, ventral 2-2-2. The terminal joint is somewhat longer than Patella + Tibia, about as long as the femur. There is a row of three trichobothria on the tibia and two rows of comparatively short trichobothria on the terminal joint. The palpal claw (Fig. 377) is more slender and shorter than the tarsal claws, with six teeth increasing in length distally.

Abdomen elongated, wider in front than behind, 1.4 mm. long, 0.7 mm. high, 0.8 mm. wide. Viewed from above it is oval in shape. It is sparsely clothed with long, brown hair.

Six spinnerets. Anterior pair (Fig. 378) contiguous at base. Posterior pair much more slender, about half the diameter of the anterior pair, separated by the anal tubercle. Median pair very small, contiguous. Colulus wanting. No trace of an epigynum can be seen.

#### *Family Zodariidae*

This is a peculiar family in which both the claws and the spinnerets are subject to reduction in number. In the case of the claws it is naturally the third claw which becomes rudimentary and even disappears completely. In the case of the spinnerets the rudimentation and final disappearance may involve either only the

median spinnerets or two pairs of spinnerets. Only recent spiders belonging to this family were known up to the present. The fossil Genus *Anniculus* described below is new to science. It is related to the recent Genus *Patiscus*, but shows some characters which are sufficiently different to necessitate the erection of a new genus and lacks other characters such as tarsal scopulae and claw tufts. The lack of these characters is, however, in my opinion not sufficient for the establishment of a new subfamily. It is a manifestation of the same process of rudimentation exhibited by the claws and the spinnerets.

Subfamily *Storenomorphinae*

Genus *Anniculus*, nov.

Carapace not much narrowed in front. Head much wider than the eyegroup. Eight eyes in two rows, both slightly procurved. AME largest. Lateral eyes contiguous. Thoracic groove longitudinal. Chelicerae stout, with very short fangs. Maxillae strongly inclined over lip. Sternum almost circular, truncated in front, convex. First coxae very wide apart. Pedal scopulae and claw-tufts wanting. Two claws. Female palp with claw. Two spinnerets on a common pedestal. Hair of different types, simple and plumose. Type *A. balticus* n. sp.

(Derivation of name: Latin—*Anniculus*—a yearling.)

*Anniculus balticus*, n. sp. Plate X, Figs. 86 to 90. Plate LVII, Fig. 530.

British Museum, Klebs 507, No. 13435. In. 18749.

Type. Female. Total length 5.6 mm. Carapace (Fig. 86) 2.4 mm. long, 1.6 mm. wide opposite second coxae where it is widest, rounded behind, gradually, but very little narrowed in front. In the region of the eyes the head is 1.28 mm. wide. The thoracic groove is longitudinal, deep, in the region of the second coxae. The head is slightly, but distinctly delimited from the thorax. The highest point of the head is about one-third of the total length of the carapace from its anterior edge. From this point on the head slopes forward in a curve. It also slopes backward so that the thorax is lower than the head. The posterior declivity is gradual, not steep. The surface of the carapace is glabrous. A few bristles are present on the face. Those between the AME are stouter and longer than the rest.



The eyegroup is only 0.8 mm. wide, *i. e.* considerably narrower than the head. Eight eyes in two rows. Both rows are slightly procurved when viewed in a certain position. Ratio of eyes AME: ALE: PME: PLE = 8:7:5.5:5.5. The quadrangle is wider in front than behind in ratio 17:14, wider than long in ratio 17:14. The AME are separated by one-half of their radius and are practically contiguous with the ALE. The PME are separated from each other by the radius of the AME and from the PLE by 6/8 of the diameter of the AME. The clypeus is very high, slightly convex, vertical. Its height is 0.56 mm., *i. e.* the clypeus is higher than the quadrangle in ratio 23:14.

Chelicerae very stout, cone-shaped, with very short fangs. View of margins obstructed by dirt. Maxillae (Fig. 88) inclined over lip, meeting in median line. Palps inserted at their base. Lip free, triangular, longer than wide. Sternum almost circular, rounded behind, truncated in front, convex, roughly granular. First coxae wide apart. Fourth coxae separated by half their width. Legs rather stout and short, with few short and stout spines.

Leg formula	$\frac{4}{2.5}$	$\frac{1}{2.3}$	$\frac{3}{2.3}$	$\frac{2}{1.9}$	
	Femur	Pat. + Tib.	Metat.	Tarsus	Total
I	1.44	1.84	1.24	0.92	5.44
II	1.36	1.20	1.20	0.88	4.64
III	1.40	1.80	1.32	0.88	5.40
IV	1.76	2.04	1.60	0.60	6.00

Width of first patella 0.264 mm. First tibial index 14.3.

Width of fourth patella 0.240 mm. Fourth tibial index 11.7.

*Spines.* First leg. Femur dorsal 1-0-1, elsewhere 0. Patella 0. Tibia ventral 1-1-2 rather long and fine spines, the first near base, the second a little beyond middle. Elsewhere 0. Metatarsus ventral 1 apical, elsewhere 0.

Second leg apparently same as first.

Third leg. Femur dorsal 1-1-0, elsewhere 0. Patella not well visible. Tibia dorsal 1 close to base, retrolateral 1 apical, elsewhere 0. Metatarsus retrolateral 1-1, rest not well visible.

Fourth leg. Femur dorsal 1-1-1, elsewhere 0. Patella retrolateral 1, elsewhere 0. Tibia dorsal 0, prolateral 0-0-1, retrolateral 1-0-1, ventral 0-1-1. Metatarsus dorsal 1-1, the first spine just

before middle, the second apical. Ventral 1-1-1, the first spine close to base, the second in middle. Elsewhere 0.

Two claws, similar, with 2 or 3 teeth, rather large, evenly curved. Claw tufts wanting. The ventral surface of all metatarsi and tarsi is covered with stiff, very short bristles which simulate a scopula, but a true scopula is wanting. Under high power these bristles look almost like spines, but are naturally much shorter. The rest of the leg is clothed with plumose hair (Fig. 87) which is recumbent, short, white and with from two to five branches on each side of the shaft. Trichobothria are apparently wanting.

The petiolus (Fig. 89) is fully exposed, and rather unusually long. The lorum is composed of two pieces, both of nearly the same length. The anterior piece is wider than the posterior piece and is accompanied by narrow lateral sclerites. The front and rear edge of the anterior piece are both emarginate, while in the posterior piece only the anterior edge is emarginate.

The abdomen is ellipsoidal, placed almost on its side, probably while the spider struggled in the gum. Without the petiolus the abdomen is 2.8 mm. long and 2.0 mm. high. Its width cannot be measured. The abdomen is clothed with very short, simple hair. Two spinnerets on a common pedestal (Fig. 90). They are fairly long, more or less cylindrical, with a short, rounded terminal joint. The two spinnerets are contiguous at base. There is no colulus visible and it is undoubtedly wanting.

The palpi are of the female type, with a claw. The position of the palpi prevents more detailed study.

#### Family *Spatiatoridae*, nov.

This new fossil family includes two genera, *Spatiator* and *Adorator*, both also new. As will be seen from the description of the species many of the characters are in common with some *Zodariidae* without permitting their inclusion in any of the subfamilies of the latter family. If the familial affiliation were beyond any doubt a new subfamily could be erected for these fossil spiders. Unfortunately they possess other characters found not among the *Zodariidae*, but among such *Drassodidae* as *Lampona* and among some *Palpimanidae*. Neither the heart, nor the tracheal system being known the wisest course seems to be the erection of a new family.

Characters of the family. Carapace only slightly narrowed in

front. Thoracic groove longitudinal. Head clearly set off and elevated above the carapace, appreciably wider than the eyegroup. Clypeus high. Eight eyes in two rows. Chelicerae parallel, with oblique margins, without boss. Promargin smooth, with a scopula. Retromargin armed with two teeth. Maxillae with distal inner corner drawn out to such an extent that the two points almost meet in front of the lip. Lip free, convex, longer than wide, with curved sides and bluntly pointed end. Sternum truncated in front, convex. First coxae wide apart. Legs with rather long patella. Claw tufts wanting. Three claws. Upper claws similar, pectinate in a single row. Third claw greatly reduced, thorn-like. Serrated bristles present, but spurious claws wanting. Trichobothria few. Hair of various simple types present, also spatulate hair forming scopulae on the tarsi and metatarsi. Six spinnerets. Anterior pair contiguous, stouter and longer than posterior pair, which is separated by the width of the anal tubercle. Median pair short and slender. Colulus present or wanting.

#### Key to Genera

1. Legs without spines, fourth leg longest. Upper claws with 4 teeth in a median ventral row . . Genus *Spatiator*.
- \* Legs spinose, first leg longest. Upper claws with 6 or 7 teeth originating on the medial surface of the claw . . .

Genus *Adorator*.

#### Genus *Spatiator*, nov.

Carapace but little narrowed in front. Thoracic groove longitudinal. Head elevated above the thorax and clearly delimited. Clypeus high, vertical. Eight eyes in two rows. Eyegroup considerably narrower than head. Anterior median eyes largest. Sternum widely truncated in front. Lip longer than wide, pointed in front. Chelicerae parallel, with oblique margins, without boss. Promargin smooth, with a scopula. Retromargin armed with two teeth. Maxillae with antero-median angle drawn out to a point, strongly inclined over lip. Palp inserted at end of maxilla. Female palp with claw. Anterior coxae wide apart. Legs without spines. Fourth legs longest. Patellae unusually long. Three claws. Upper claws similar, with 4 teeth originating on medio-ventral surface. Third claw thorn-like, wanting on the first and second tarsi in the male. Metatarsal and tarsal scopulae formed

ly spatulate hairs. Claw-tufts wanting, but serrated bristles present. Colulus wanting. Six spinnerets. Anterior pair contiguous, longer and stouter than the others. Type *S. praeceps* n. sp.

(Derivation: Latin—*Spatiator*—a promenader.)

*Spatiator praeceps* n. sp. Plate XVIII, Figs. 169 to 176, Plate XIX, Figs. 177 to 185, Plate LXII, Fig. 569, Plate LXIII, Fig. 578.

a) British Museum, Klebs 518, No. 3761, In. 18760. Type.

b) British Museum, Klebs 519, No. 3764, In. 18761. Androtype.

Type. Female. A fairly well preserved specimen in clear amber which, however, contains many air-bubbles reflecting light. The carapace is complete, but for some reason the chitin of its posterior half has completely disappeared leaving only a transparent, glass clear amber mould. The first impression therefore is that the posterior half of the carapace is missing. Only by placing the specimen so that it appears in profile one becomes aware of the fact that the mould of the entire carapace is preserved. The ventral surface of the specimen is rather heavily coated with white emulsion. The color of the chitin is almost black, the abdomen light brown.

Total length 5.4 mm. Carapace (Fig. 169) 2.37 mm. long, 1.42 mm. wide between second and third coxae where it is widest, slightly narrowed in front. Its shape is rather unusual. Its posterior margin is evenly rounded, the lateral margins are strongly convex, become concave in the region where the head begins and turn again convex further on. In a lateral view (Fig. 175) one can see that the thoracic region is rather low, while the head, clearly set off from the rest of the carapace is considerably higher. Its highest point is considerably behind the eyegroup. From here the head slopes forward and backward in a curve which is much steeper in its posterior than in its anterior portion. A crest of short bristles extends over the full length of the head. On account of the transparency of the thoracic portion the thoracic groove cannot be seen. It is probably present because, as we shall see, it is well visible in the male.

Eight eyes. The AME are largest, subcontiguous. The right posterior median eye is not well visible, but its position can be easily figured out from the other eyes of the same row. The

lateral eyes are contiguous. Viewed from in front the first row of eyes is distinctly downcurved. The total width of the eyegroup is 0.5 mm. The clypeus is vertical, concave and nearly twice as high as the diameter of the AME.

The chelicerae are powerful, fairly long. Their armature cannot be seen. Maxillae and lip completely hidden by white emulsion. The sternum is also completely covered with white emulsion, but owing to the extraordinary transparency of the carapace the inner surface of the sternum may be seen through the latter. One can also see that the outer surface of the sternum is clothed with fine, short hair. Furthermore, one can see the coxae and the lorum of the petiolus. The first coxae are wide apart. The fourth coxae are separated by about half their width. The cephalothoracic openings of the coxae into the cephalothorax appear to be round. The lorum of the petiolus is flanked on each side by a lateral sclerite.

The legs are peculiar in various ways. The first femora are by far the stoutest and are distinctly sigmoid. The patellae are unusually long, being more than half as long as the tibiae. The metatarsus of the second leg is shorter than the tarsus, but not so on the other legs.

Leg formula	4	1	2	3		
	2.5	2.3	2.2	1.8		
	Femur	Pat. + Tib.	Metat.	Tarsus	Total	
I	1.60	2.20	0.84	0.84	5.48	
II	1.60	2.00	0.80	0.88	5.28	
III	1.36	1.60	0.80	0.56	4.32	
IV	2.00	1.92	1.36	0.56	5.84	

Length of second patella 0.79 mm. Length of second tibia 1.28 mm.

Width of first patella 0.264 mm. First tibial index 12.

Thick scopulae on all metatarsi and tarsi composed of spatulate hairs (Fig. 176). Elsewhere on the legs the hair is of the simple type, short and stiff. Trichobothria are few and difficult to see. There seem to be several in a row on the tibia and at least one trichobothrium can be seen on the metatarsi beyond the middle. Apparently there are none on the tarsi. Three claws (Fig. 171). Upper claws similar, curved, with four stout teeth each. Third

claw almost straight, smooth. Spurious claws and claw tufts are wanting, but one can see under the claws a series of serrated bristles. These serrations are plainly visible under high power.

The abdomen has a very characteristic shape. Viewed from below its sides appear parallel in the anterior two-thirds. Posteriorly they converge almost to a point. Viewed from the side (Fig. 170) the abdomen is quite high in the anterior third, slopes almost vertically down toward the petiolus, and much more gradually toward the end of the second third. From here on it forms a convex curve through the last third. This region is transversely divided by eight grooves which are probably remnants of segmentation. The abdomen is clothed with short, brown hair. The total length of the abdomen is 2.8 mm. the width 1.6 mm. and the height 1.4 mm. The spinnerets (Fig. 174) occupy a perfectly circular field set in a circular groove. The anterior spinnerets are contiguous, larger and longer than the others, and each has three spigots on its terminal joint. The posterior spinnerets are separated by the width of the anal tubercle. The median spinnerets are quite small, situated between the posterior spinnerets, and form with the latter a straight line. Both the median and the posterior spinnerets have only simple spinning tubes. The anal tubercle is wide and low. Whether a colulus is present or wanting cannot be decided because of white emulsion obstructing the view.

The palpi are only partly visible. They are of the female type and some prolateral spines are visible on the tibia.

*Androtype.* Male. A well preserved specimen in clear amber. A large air-bubble obstructs the view of the mouth parts and sternum from below. To make these visible a hole had to be drilled from below to the surface of the air-bubble. The specimen was then placed in oil and the air sucked out with the aid of a very fine pipette admitting the oil into the cavity. This made all structures perfectly visible. The color of the carapace and the legs is dark reddish brown. The legs are somewhat lighter below. The abdomen is silvery grey, darker in the pregenital region. The abdomen is displaced and forms an angle of ca.  $120^{\circ}$  with the carapace. The total length can be therefore only estimated as a sum of two measurements.

Total length 4.2 mm. Carapace 2.08 mm. long, 1.20 mm. wide between second and third coxae where it is widest (Fig. 177).

Thoracic portion oval, with a deep, longitudinal thoracic groove. The head is very sharply set off from the rest of the carapace and elevated above it. The posterior end of the head is almost semi-circular, the sides almost straight and barely converging anteriorly. Eyegroup narrower than head. Posterior declivity very gradual. It begins at the posterior end of the thoracic groove. Three pairs of thoracic sulci radiate from the depression surrounding the groove. The surface of the thoracic portion is distinctly granular and devoid of hair. The head rises in a steep curve to its greatest height (Fig. 179) about one-quarter of the total length of the carapace from the anterior edge. From here the head slopes forward in a continuous curve. The surface of the head is smooth except for two rows of short bristles. Eight eyes in two rows. First row strongly recurved, second row gently procurved and a little longer than the first row. Width of eyegroup 0.43 mm. The entire eyegroup is elevated on a low tubercle. The AME are by far the largest, all the other eyes are equal in size. The lateral eyes are contiguous. The quadrangle is wider in front than behind in ratio 12:7, wider than long in ratio 12:10. The AME are separated from each other by half their radius. They are contiguous with the ALE. The PME are separated from each other by somewhat less than their diameter and from the PLE by their diameter. However, exact measurements are made difficult by the dark color. The clypeus is vertical, higher than the length of the quadrangle. The AME project beyond the clypeus.

The chelicerae (Fig. 180) are parallel, without boss, with oblique, rather short margins. The promargin is smooth, with a scopula. The retromargin is armed with two, very pointed teeth. The fang is short, evenly curved and rather fine. The maxillae (Fig. 178) have a rather peculiar shape. Their inner edge is concave and the distal inner angle is drawn out to a point so that the two maxillae almost meet in front of the lip. They are wider in front than at the base, have a distinctly convex surface and the palp is inserted at the distal outer angle. The lip is convex, longer than wide, rounded at end, with converging, curved sides.

The sternum is longer than wide in ratio 10:9. Anteriorly it is so truncated that the central third for the accommodation of the lip is transverse while the sides for the reception of the maxillae are at an appreciable angle to the longitudinal axis of the sternum. The sides of the sternum converge in a curve to a blunt point

between the hind coxae. First coxae very wide apart. Fourth coxae separated by half their width. The surface of the sternum is distinctly convex, shiny with very little pubescence.

The legs are peculiar in several respects. All femora, but particularly those of the first and second pair are distinctly sigmoid. The patellae are unusually long. The tarsi of the first and second pair are longer than the corresponding metatarsi. The second metatarsi are distinctly downcurved. Scopulae are wanting, but spatulate hairs of the same kind as in the type are present on the second metatarsi. On the dorsal surface of all tarsi there are erect hairs curved forward. These hairs are particularly long on the second tarsi and form here a regular dorsal comb (Fig. 184). One must not confuse them with trichobothria. The latter are very difficult to see and are apparently wanting on the tarsi. One can see a row of 3 trichobothria on the fourth metatarsi, but not anywhere else.

Leg formula	$\frac{4}{2.6}$	$\frac{2}{2.3}$	$\frac{1}{2.2}$	$\frac{3}{1.8}$
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	Femur	Pat. + Tib.	Metat.	Tarsus	Total
I	1.32	1.60	0.76	0.80	4.48
II	1.40	1.76	0.72	0.80	4.68
III	1.08	1.36	0.76	0.45	3.65
IV	1.60	1.80	1.20	0.72	5.32

Width of first patella 0.192. First tibial index 12.

Width of fourth patella 0.168. Fourth tibial index 9.3.

Spines wanting.

First and second tarsi with only two claws. Both claws similar, with four teeth each. Third and fourth tarsi with three claws (Fig. 185). Upper claws of the same type as on the anterior pair of legs, third claw short, thorn-like. Claw tufts wanting on all tarsi, but very finely serrated bristles are present under the claws.

The petiolus is very well visible from above and has the same structure as in the type. The abdomen is ovoid, with finely stippled surface, with a short hair on each "pin-prick." In side view the abdomen appears to be highest in the anterior third, somewhat depressed in the middle third and gradually sloping downward in the last third. Without the petiolus the abdomen is 2.0 mm. long, 1.12 mm. wide. The anal tubercle is large, cone-shaped.



Six spinnerets. Anterior pair much longer and stouter than posterior pair (Fig. 181). Their terminal joint is hemispherical and carries three spigots. At base the anterior spinnerets are subcontiguous. The posterior pair are wide apart. They, too, have a hemispherical terminal joint, but only common spinning tubes are present. The median pair are cylindrical, more slender and shorter than the posterior pair. A colulus is wanting.

The most characteristic feature of the palpi is the ventro-prolateral row of tubercles on the femur (Fig. 183) as well as the shape of the femur itself. It is considerably thicker in middle than at base. The patella is shorter than the tibia and the latter has no apophysis. The cymbium is flexed against the femur and only its general outline can be seen (Fig. 182). It is larger than tibia + patella, oval, densely clothed with short, serrated bristles and has a few long bristles on its prolateral surface. The structure of the bulb cannot be studied in any position.

*Spatiator praeceps* has some features in common with the spider described by Koch and Berendt under the name *Therea petiolata* and represented on their Plate VIII, Fig. 69. But the figure shows only six eyes as stated by the authors, and Menge confirms that this is the correct number. For this reason *Therea* was placed in the Family *Dysderidae* in the vicinity of *Segestria*. The proportions of the legs in as far as one can judge from the conventionalized drawing are different in *Spatiator* and *Therea*. The latter seems to have shorter patellae and tarsi. *Spatiator* shows affinities to *Segestria*, but also to *Palpimanus*, *Storena*, *Lampona* and *Caponia*. Its maxillae are more like those of *Palpimanidae* than *Zodariidae*, its spinnerets more like *Segestria*. The palp is more as in *Palpimanidae*, but the coxae as in *Segestria*. The proportions, especially of the legs, are more or less as in *Lampona* and *Caponia*, but other characters prevent the inclusion of *Spatiator* in either of these genera and their respective families.

#### Genus *Adorator*, nov.

Posterior eyes slightly larger than anterior eyes. Chelicerae with boss. Legs with spines. First leg longest. Upper claws with six or seven teeth originating on the medial surface of the claw. Scopulae wanting. Colulus well developed. Other characters as in *Spatiator*. Type *A. brevipes* n. sp.

(Derivation of name: Latin—*Adorator*—an adorer.)

Key to Species

1. Tibia of palp with a long dorsal wide and blunt apophysis.  
PME separated by almost their radius ... *A. brevipes*.
- \* Tibia of palp with a short ventral apophysis. PME contiguous ..... *A. samlandicus* n. sp.

*Adorator brevipes* n. sp. Plate XI, Figs. 95 to 100, Plate LX, Fig. 553.

British Museum, Klebs 474, No. 13455, In. 18716.

Type. Male. The specimen is in clear amber. The abdomen is placed at an angle to the cephalothorax, exposing the petiolus, but making measurement of the total length of the spider impossible except as a sum of two measurements. White emulsion covers the ventral surface and an insect obstructs part of the view. The removal of this insect is not practicable because it would inevitably result in the polishing off of several legs of the spider.

Total length 3.8 mm. Carapace 1.9 mm. long, 0.8 mm. wide in the region of the eyegroup, 1.1 mm. wide between the second coxae where it is widest. The thoracic portion is flat, rising very gradually from its posterior margin to the posterior margin of the head. The cephalothoracic sulci (Fig. 95) set off the head sharply and reach the lateral margins of the carapace in the region of the first coxae. The thoracic groove is longitudinal, deep. The head is considerably elevated above the thorax. Its highest point is about two-thirds of the length of the head behind its anterior end. The head slopes in a curve forward and backward. Its surface, like that of the rest of the carapace is distinctly shagreened. There are also some long bristles present on the head, but not elsewhere.

The eyegroup is much narrower than the head. The first row of eyes is considerably shorter than the second row. Viewed from above both rows are procurved, the first row gently, the second row more distinctly. The width of the eyegroup is 0.39 mm. The ALE are on tubercles. A transverse ridge is formed by the eyegroup, separating the PME from all the other eyes when viewed from in front. In this position both rows are strongly down-curved. Ratio of the eyes AME : ALE : PME : PLE = 7 : 7 : 8 : 8. The AME are on a common tubercle which is transversely oval and clearly visible in a front view. They are practically contiguous,

separated only by a long bristle. The PME are separated from each other by slightly less than their radius and from the PLF by their diameter. The quadrangle is wider behind than in front in ratio 8:5.5, as long as wide. The clypeus (Fig. 97) is as high as the quadrangle. There are a few stout, light brown bristles on the clypeus.

The chelicerae are stout, with a boss visible in certain positions when the view is not obstructed by the palpi. The front surface of the chelicerae is clothed with light brown bristles. Neither the margins, nor the fangs are visible. Similarly, the view of the maxillae, lip and sternum is obstructed by white emulsion. But the coxae are sufficiently visible to give a clear idea of their arrangement. The first coxae are very wide apart. The fourth coxae are contiguous.

Leg formula	1	4	2	3	
	1.9	1.8	1.7	1.4	
	Femur	Pat. + Tib.	Metat.	Tarsus	Total
I	1.03	1.18	0.79	0.58	3.58
II	0.96	1.15	0.72	0.53	3.36
III	0.79	0.84	0.67	0.43	2.73
IV	1.08	1.20	0.77	0.48	3.53

Width of first patella 0.192 mm. First tibial index 16.

Width of second patella 0.216 mm. Second tibial index 19.

Width of third patella 0.192 mm. Third tibial index 20.

Width of fourth patella 0.216 mm. Fourth tibial index 18.

The third patella is as long as the third tibia.

First and second leg with relatively few spines. Third and fourth leg with numerous spines.

*Spines.* First leg. Femur dorsal 1 apical bristle, elsewhere 0. Patella 0. Tibia ventral 0-1, elsewhere 0. Metatarsus retrolateral 1 apical, ventral 1 apical, elsewhere 0.

Second leg, same as first, except: Metatarsus ventral 1-1-1.

Third leg. Femur dorsal 1-1 bristles, elsewhere 0. Patella dorsal 1 apical bristle, prolateral 1, retrolateral 1, ventral 0. Tibia dorsal 1-1-0, prolateral 0-1-0, retrolateral 0-1-1, ventral 2-2-2. Metatarsus dorsal 0, prolateral 0-0-1, retrolateral 1-1-1, ventral 2-2-2.

Fourth leg same as third, except: patella prolateral and retro-

lateral are bristles and not spines. The same holds for the pro-lateral and retrolateral armature of the tibia.

Three claws. Upper claws similar, curved, rather short and stout, with a series of six teeth originating from the medial surface of the claw (Fig. 100). Third claw small, straight, thorn-like. Claw-tufts and serrated bristles wanting.

Trichobothria few, but rather long. One on tibia before middle, 1-1-1 on metatarsus and 1-1 on tarsus.

The legs are clothed with simple hair of varying length.

The abdomen is ellipsoidal, 2.0 mm. long, 1.2 mm. wide, evenly rounded at both ends. The dorsal surface is clothed with few, long, dark yellow bristles and more numerous hair of varying length, but of the same dark yellow color. The ventral surface is covered with white emulsion except for the spinnerets which are very well preserved (Fig. 98). The anterior pair are both longer and stouter than the posterior pair. They are contiguous, only slightly finer toward the end, with a hemispherical terminal joint. The posterior spinnerets are cylindrical, short, with a hemispherical terminal joint. They are separated by the width of the anal tubercle. The small median spinnerets form a transverse row with the posterior pair. The colulus is long, well developed. The anal tubercle is large, cone-shaped. A small mite clings to its base and is easily mistaken for some peculiar structure. Examination under high power reveals its nature.

The palp is difficult to study. Its tibia has a broad and blunt dorsal apophysis (Fig. 99). The cymbium is very convex. Of the bulb only the outline is visible.

The color of the chitin is rufous on the carapace and legs, much lighter on the abdomen where a median rufous line is also present.

*Adorator samlandicus* n. sp. Plate XI, Figs. 101, 102, Plate XXV, Fig. 232, Plate LIX, Fig. 552.

Type. Male. British Museum, Collection from Samland, In. 18144.

A poorly preserved specimen in fairly clear amber. Posterior end of abdomen polished off by the previous owner so that only the anterior pair of spinnerets is left of the spinning group. The color of the chitin is generally dark brown with the abdomen slightly lighter.

Total length 3.4 mm. The carapace is almost completely hidden

under the bent legs. It is 1.8 mm. long, 1.4 mm. wide between the third coxae, 1.2 mm. wide in front. It rises gradually from the posterior margin forward. The head is considerably higher than the thorax. The eyegroup is almost completely covered by the first left leg and by some dirt. The eyes are visible in face view even though the view is partly obscured by the palpi. The AME are small and close together. From the ALE the AME are separated by a little more than their diameter. The PME are contiguous and larger than the ALE. With the PLE the PME are subcontiguous. Viewed from in front the eyegroup appears as a semicircle open anteriorly, with the AME situated in front of the arc. The clypeus is twice as high as the diameter of the AME. Exact measurements are not possible.

The chelicerae are stout, their basal joint about as long as the head is high, clothed with stiff bristles in front and on the outside. There is a distinct cone-shaped protuberance at the end of the basal joint on the outside surface near its lower edge, *i. e.* a distal retrolateral protuberance. Neither the margins, nor the fangs can be seen, nor is it possible to decide whether a boss is present or wanting.

The lip is longer than wide, more or less triangular, with straight suture. The maxillae are inclined over the lip (Fig. 232) with pointed inner distal angle. The sternum is wide in front, transversely truncated to almost its full width. It is longer than wide in ratio 5:4, slightly convex and is truncated between the hind coxae. First coxae wide apart, fourth coxae separated by almost their width. The legs are fairly stout and short.

Leg formula	1	4	2	3
	2.4	2.2	2.1	1.8

	Femur	Pat. + Tib.	Metat.	Tarsus	Total
I	1.20	1.60	0.88	0.60	4.28
II	1.20	1.28	0.80	0.48	3.76
III	1.12	1.04	0.68	0.48	3.32
IV	1.20	1.60	0.72	0.48	4.00

Spines are present, but difficult to see. Their view is obstructed by dirt adhering to the legs. One can see clearly 2-2-2 ventral spines on the first and second tibia, also 2-2-2 ventral spines on the metatarsus of the same legs. On the left third patella a retrolateral spine is visible. On the tibia of this leg 0-1-1 retrolateral

spines and on the metatarsus 1-1 retrolateral spines are visible. On the fourth tibia and metatarsus one can see 2-2-2 ventral spines. There are probably other spines on all legs present, but as stated dirt prevents seeing them.

Claw-tufts and scopulae wanting. The legs are clothed with long hair having the appearance almost of bristles. Three claws. Upper claws powerful (Fig. 102) evenly curved, with a row of six long teeth on the anterior two pairs of legs, with seven teeth on the posterior two pairs. The teeth originate on the surface of the claw which is nearest the median plane, so that on the proclaw they originate on the retrolateral surface, while on the retroclaw on the prolateral surface, like mirror images of each other. A short, thorn-like third claw is visible on two of the legs.

At a magnification of 350 diameters one can see a few ventral spines toward the end of each tarsus—a very unusual condition.

The abdomen is 1.4 mm. long, 1.05 mm. wide and is clothed with bristles.

Both palpi are visible. The femur (Fig. 101) is longer than patella and tibia combined. The tibia has a median ventral apophysis, thorn-like, but blunt at the end. The cymbium is as long as the femur. The most characteristic feature of the bulb is the scoop-like structure deeply emarginate at the end.

Family *Theridiidae*

Subfamily *Theridiinae*

Genus *Theridion* Walckenaer, 1805

Type: *T. lineatum* (Clerck)

The two specimens placed here in the Genus *Theridion* are really of very uncertain generic affiliation. As defined at present the Genus *Theridion* possesses very definite characters. The specimens in question do not exhibit the combination of characters found in *Theridion*. If they are nevertheless referred by me to this genus it is because they could not be referred definitely to any other genus. Under other circumstances this would give sufficient reason for the erection of a new genus. Unfortunately one specimen is very young and the other specimen is in a very poor piece of amber making detailed study almost impossible. It is also impossible to decide whether either of the two specimens belongs to a known species. Koch described seven species from the Baltic amber under the generic name *Theridium*, namely *T. ovatum*,

*T. ovale*, *T. simplex*, *T. hirtum*, *T. granulatum*, *T. alutaceum* and *T. detersum*. According to Menge (p. 43 note) *Mizalia globosa* Koch and Berendt is also probably a *Theridium*. Menge mentions in a footnote on page 6 his own collection and lists five species, *Theridium clavigerum*, *bifurcum*, *chorius*, *crassipes* and *setulosum*, without giving any descriptions or figures. They are therefore nomina nuda. Heer described three species, *T. annulipes*, *T. globulus* and *T. maculipes* from the German Tortonian. Thorell described *T. bucklandi* from the French Ligurian. Whether all or any of the above species really belong to the Genus *Theridion* as defined at present remains questionable. The character most important for the recognition of the family, namely the presence of the so-called comb on the fourth tarsi is not even mentioned in the descriptions of the above species. As a matter of fact it was not recognized until much later and even Keyserling did not know its value. The comb is subject to variation even in recent spiders. There are genera in which it is very poorly developed. In such cases one has to find corroborative evidence in other characters such as chelicerae, lip, maxillae, eyes, etc. The figures given by Koch make me suspect that some of his species are Linyphiids and not Theridiids.

(?) *Theridion simplex* Koch and Berendt. Plate XLVII, Figs. 439 to 441. British Museum Collection from Samland, In. 18135.

*Theridium simplex* Koch and Ber., 1854, p. 35. Tab. IV, Fig. 24. The piece of amber containing this specimen is so full of planes of cleavage containing air pockets that clear vision is impossible. On first inspection one gets the impression that the carapace has the same shape as in *Micryphantès infulatus* K. & B. figured by the authors on Plate IV. However, careful examination in different lighting and from different angles of view reveals the fact that such is not the case. Far from having to do with a highly elevated head, we have really such a displacement of the carapace before us that its dorsal aspect is mistaken for a side view. Its true shape is represented in Fig. 439. The thoracic portion is oval, slightly longer than wide. The head is clearly set off from the rest of the carapace, but is not elevated above the latter. The thoracic groove is longitudinal. The posterior margin is provided with a semicircular emargination for the reception of the petiolus.

Six of the presumably eight eyes are visible, but their exact dis-

position cannot be determined. Mouthparts and sternum are heavily coated with white emulsion.

The abdomen is best visible from the left side (Fig. 440). The genital opening, the left lung slit and the outline of the left lung are well visible. The left anterior and posterior spinnerets are also visible. The former is somewhat stouter and longer than the latter. The abdomen is sparsely clothed with long, curved bristles.

The legs are moderately thin and long. They are placed in such a position that measurements are quite impossible. Fine and fairly long spines are visible on several joints, as for example 1-1 dorsal spines on the tibia. A comb is present on the fourth tarsus (Fig. 441) but the row of dorsal bristles is almost as well developed as the comb.

The claws are difficult to see. There are certainly three claws. The upper claws seem to be smooth.

#### *Theridion* sp?

Crosby collection of Cornell University, No. 9.

A very small spiderling in fairly clear amber. Total length 1.1 mm. Carapace 0.60 mm. long, 0.41 mm. wide between second and third coxae where it is widest. It is rather high and is narrowed anteriorly to somewhat less than the width of the eyegroup so that the lateral eyes project beyond the carapace on each side of the head. The examination of the spiderling is made difficult by its position in the amber and by numerous, strong reflections. Eight eyes in two rows. As far as visible the quadrangle is slightly wider in front than behind and about as long as wide. The AME are distinctly larger than the PME and are closer together than the latter. Viewed from in front the first row appears to be down-curved and shorter than the second row, so that in this position one sees only the eyes of the first row and the PLE. The lateral eyes are contiguous. The clypeus is about as high as the quadrangle. Of the chelicerae only the basal joint can be seen. It is about as long as the distance from the edge of the clypeus to the vertex of the PME.

The lip is wider than long. The maxillae are parallel, more or less truncated in front. The palps arise from their base. The sternum is very convex, heart-shaped, wide and slightly emarginate in front, bluntly pointed behind, as long as wide. The first coxae



are wide apart. The fourth coxae are separated by about twice their width. The legs are clothed with few, but rather long hairs. No true spines are present, but rather long bristles are visible in the usual position on the patella (dorsal 1-1) and tibia (dorsal 1-1). A row of hairs on the fourth tarsi may be interpreted as a primitive comb. Trichobothria few, apparently only on the tibiae where one can see two of them, one a little to the side and in front of the other. The general appearance of the legs is that of a very young individual.

Leg formula	1	2	4	3	
	2.6	2.2	2.0	1.6	
	Femur	Pat. + Tib.	Metat.	Tarsus	Total
I	0.48	0.48	0.31	0.29	1.56
II	0.38	0.41	0.26	0.24	1.29
III	0.29	0.31	0.18	0.18	0.96
IV	0.38	0.41	0.22	0.19	1.20

The abdomen is distinctly theridoid, pointed behind, sparsely clothed with long bristles. It is 0.70 mm. long, 0.55 mm. wide in its widest place. At the posterior end one can see lines which may represent remnants of segmentation. Six spinnerets in a rosette. Anterior pair cone-shaped, contiguous. Posterior pair somewhat shorter and more slender than anterior pair. Median pair small and barely visible. Colulus wanting.

Genus *Flegia* Koch and Berendt, 1854

Type: *F. longimana* K. & B.

This genus appeared first as a nomen nudum in 1845 in the list of Baltic amber spiders on p. 56 of Berendt's monograph. No species was assigned to it, nor any definition of the genus given. In 1854 the species *longimana* was placed by Koch and Berendt in the Genus *Flegia* and a figure and a detailed description of the spider given, but the authors omitted a definition of the genus. The Genus *Flegia* was placed by the authors in the Family *Therididae* which at that time included also the species which now are generally placed in a separate Family *Linyphiidae*. Koch states on p. 30 that the disposition of the eyes resembles that in *Linyphia*. Another character usually present in *Linyphia* and mentioned by Koch in his description of *Flegia longimana* is the presence of fine bristles on the patella and tibia (die gewöhnlichen Knie und Schien-

enbeinborsten). None of the characters now used for the recognition of the family and for the separation of its genera are either mentioned or figured by Koch. Menge states in a footnote on p. 30 that the species seems to be related to *Episinus* and corrects some of Koch's descriptions. That genus is placed now in the Subfamily *Theridiinae*. Unless Koch's original specimen were available, neither his species nor the genus could be characterized. For this reason the species described here as *Flegia succini* must be regarded as new and the following definition of the genus is based on the characters of that new species.

#### Definition of the Genus

Fourth tarsi with a comb of serrated bristles. Carapace rather flat. Eight eyes in two rows, all equal. First row strongly recurved, second row straight. Quadrangle rectangular, very slightly wider than long. Chelicerae with short, transverse margins. Maxillae strongly inclined over lip. Sternum shield-shaped, slightly longer than wide. First coxae wide apart. Legs slender and fairly long, in order 1243, without spines, with fine 1-1 dorsal bristles on patella and on tibia. Three claws. Upper claws similar, with four teeth each. Abdomen ellipsoidal, with six spinnerets forming a rosette. Anterior pair much stouter than posterior pair. Colulus wanting. Male palp with long femur.

*Flegia succini* n. sp. Plate LII, Figs. 484 to 492, Plate LXIX, Fig. 624. A single specimen in the Peabody Museum of Yale University, fairly well preserved and showing clearly all structures. White emulsion covers a part of the sternum and peculiar incrustations on all legs and on the abdomen are present.

Type. Male. Total length 2.8 mm. Carapace 1.52 mm. long, 1.20 mm. wide between second and third coxae where it is widest, 0.64 mm. wide in the region of the eyegroup. The carapace (Fig. 484) is rather flat. The eyegroup (Fig. 488) is quite prominent giving the impression of being elevated on a common tubercle. There are fairly deep depressions between all eyes, but especially between the AME and ALE. The first row is strongly recurved. The second row is straight and slightly longer than the first. The lateral eyes are contiguous. The quadrangle is as wide in front as behind, slightly wider than long in ratio 14:13. The eyes are all equal. The total width of the eyegroup is 0.60 mm., *i. e.* only

very slightly narrower than the head. The clypeus is equal to two diameters of the AME (Fig. 485).

The basal joint of the chelicerae is almost as long as the head is high, tapering distally. Consequently, the outside edges of the chelicerae are parallel, while the inside edges are diverging. The margins are short, transverse. The fangs are also short and almost straight. The maxillae are strongly inclined over the lip, but do not meet. The lip itself cannot be seen on account of white emulsion. The palp is inserted at the base of the maxilla. The sternum (Fig. 490) is shield-shaped, very slightly convex, longer than wide in ratio 17:15. It is wide in front, bluntly pointed behind, shiny, with scarcely any hair. First coxae are wide apart. Fourth coxae are separated by almost their width. The legs are long and slender.

Leg formula	<sup>1</sup> 4.6	<sup>2</sup> 3.3	<sup>4</sup> 3.1	<sup>2</sup> 2.5	
	Femur	Pat. + Tib.	Metat.	Tarsus	Total
I	2.08	2.36	1.84	0.76	7.04
II	1.60	1.60	1.20	0.64	5.04
III	1.20	1.10	1.00	0.56	3.86
IV	1.52	1.44	1.12	0.60	4.68

Width of first patella 0.144 mm. First tibial index 6.

Width of fourth patella 0.144 mm. Fourth tibial index 10.

True spines wanting, but the usual dorsal bristles 1-1 present on all patellae and tibiae. The legs are clothed with fairly long, simple hair. The fourth tarsus (Fig. 492) with a comb of serrated bristles. Some erect hairs are visible in various places on the legs, but their distribution seems to be irregular. Trichobothria cannot be seen and possibly are wanting.

Three claws. Upper claws similar, bent, with four teeth (Fig. 491). Third claw bent at right angles, with a single tooth. At least two serrated bristles at the end of each tarsus, but rather slender and fine. Spurious claws, claw-tufts and scopulae wanting.

Abdomen ellipsoidal, 2.6 mm. long, 1.5 mm. wide, 1.5 mm. high, clothed with fine and fairly long, but sparse brown hair. The sides of the abdomen have distinct longitudinal plications. Six spinnerets (Fig. 487), forming a rosette. Anterior pair cone-shaped, considerably stouter than posterior pair and distinctly separated at base although no colulus can be seen. Median pair small. Posterior pair wide apart. Anal tubercle hemispherical.

The palp is very characteristic. Its femur is 0.72 mm. long and its relative length is unusual inasmuch as it equals the combined length of the rest of the palp (Fig. 489). At the end of the tibia are several long bristles. The cymbium and bulb are rather small. The embolus (Fig. 486) forms a single coil of a spiral.

The difference between this species and Koch's *Flegia longimana* lies in the relative size of the eyes. According to Koch the PME in *F. longimana* are distinctly larger than the AME, whereas in *F. succini* they are of the same size. Menge's two species of *Corynitis* are also distinct from *F. succini* even though their description is quite inadequate. *C. spinosa* has very long bristles on all tarsi. *C. undulata* has horse-shoe shaped grooves on the back of the abdomen. *F. succini* has neither long bristles, nor horse-shoe shaped grooves.

#### Subfamily Latrodectinae

This subfamily which includes among its five recent Genera *Dipoena* and *Latrodectus* is represented in the Baltic amber by two new Genera *Eodipoena* and *Nactodipoena*. As the names imply these genera are closely related to the recent Genus *Dipoena* from which they may be differentiated as follows:

1. Anterior median eyes much larger than the lateral eyes  
*Dipoena*
- \* Anterior median and lateral eyes of about the same size      2
2. Eyegroup much narrower than the head, transversely oval.  
All eyes equal, contiguous ..... *Eodipoena*
- \* Eyegroup not much narrower than the head. Posterior  
median eyes distinctly smaller than anterior median  
eyes. Only lateral eyes contiguous .... *Nactodipoena*

#### Genus *Eodipoena*, nov.

With the characters of the family and subfamily, except that the upper claws are dissimilar, the prolateral claw with four teeth, the retrolateral claw smooth. Head on same level with thorax. Carapace not high. Eyes in two rows forming a transverse oval, equal, contiguous. Eyegroup much narrower than the head. Clypeus one and a half times as high as the quadrangle. Sternum triangular, slightly longer than wide, flat. First coxae wide apart. Tarsal comb well developed. Type *E. oculata* n. sp.

*Eodipoena oculata* n. sp. Plate XVII, Figs. 160 to 168. Plate LXI, Fig. 565.

British Museum, Klebs 498, No. 13488, In. 18740.

Type. A well preserved mature female in almost clear amber. Ventral surface covered with white emulsion which also coats individual hairs. Color of chitin: carapace black, legs very dark brown, abdomen light brown, darker below. Spinnerets and epigynum very dark brown.

Total length without chelicerae 4.1 mm. Carapace 1.6 mm. long, 1.36 mm. wide opposite third coxae where it is widest (Fig. 160). It is narrowed in front to 0.56 mm. Viewed in profile (Fig. 162) the carapace has a fairly steep posterior declivity, but rises gradually forward so that the eye-region is the highest point. The carapace is clothed with black bristles especially noticeable in the mid-dorsal line. On account of the deep black color of the carapace the eyes are very difficult to see. They are best studied in strong light on a black background. Even then measurements of individual eyes are not feasible, but the general configuration of the eyegroup is quite clear. The eyegroup has the shape of a transverse ellipse. Its long axis measures 0.55 mm., its short axis 0.29 mm. The entire eyegroup is elevated on a tubercle. The head in the region of the eyegroup measures 0.84 mm. The clypeus (Fig. 161) is inclined and very high. It is higher than the length of the quadrangle in ratio 20:13. The first row of eyes is recurved, the second row procurved (Fig. 163). All eyes are contiguous, equal. The distance between the AME and PME is equal to one third of their diameter. The quadrangle is as wide in front as behind and as long as wide. The sides of the face are oblique. The thoracic groove is longitudinal, deep but rather short.

White emulsion obstructs the view of the chelicerae, maxillae and lip. All that it is possible to make out is that the chelicerae are rather short and weak. The appearance of the base of the fang gives the impression that the fang is slender and short. The sternum is neatly triangular, longer than wide in ratio 30:25. flat, pointed between the fourth coxae which are separated by less than half their width. First coxae wide apart. The sternum is sparsely clothed with long bristles directed forward and inward and each coated with white emulsion. In certain positions and proper light one gets a glimpse of the anterior end of the right

maxilla. Its anterior edge is straight and its outer angle is rounded.

Leg formula	4	1	2	3	
	3.3	3.2	2.9	2.4	
	Femur	Pat. + Tib.	Metat.	Tarsus	Total
I	1.52	1.72	1.08	0.80	5.12
II	1.52	1.48	0.92	0.72	4.64
III	1.20	1.20	0.80	0.68	3.88
IV	1.60	1.80	1.04	0.80	5.24

The legs are bristly in appearance, much more so than one would expect in a Theridiid. A few of the bristles have almost the appearance of slender, long spines. Their distribution is as follows: First leg. Patella dorsal 1-1. Tibia dorsal 0-1. Second leg. Patella dorsal 1-1. Tibia dorsal 0-1, retrolateral 1-0. Third leg. Patella dorsal 1-1. Tibia dorsal 1-0, retrolateral 1-0. Fourth leg. Patella dorsal 1-1. Tibia dorsal 1-0, retrolateral 0-1. The legs are clothed with hair of three different kinds. First there is stiff, long, bristle-like hair inclined forward. Then there are present on all joints short, vertical hairs (Fig. 167) which are thin at the base, widening suddenly and then tapering off gradually. I was at first tempted to interpret these hairs as having a coating of emulsion around a normal, erect stem. But apparently no emulsion is present here. In some places, as for example, under the fourth tibia where only two such hairs are present they are much shorter and have almost the appearance of spines. Serrated bristles are present on all tarsi and on the fourth pair they form a comb (Fig. 165). The latter is composed of 9 bristles. Trichobothria seem to be wanting except a single one on the first metatarsus a little beyond middle.

Three claws (Figs. 165 and 166). Upper claws dissimilar. Proclaw with four teeth, retroclaw smooth. Third claw long, bent at right angles, smooth, pointed.

Abdomen ellipsoidal, somewhat depressed above, evenly rounded at both ends. It is 2.88 mm. long, 2.70 mm. wide, 2.1 mm. high. It overhangs the carapace considerably. Its dorsal surface is clothed with short, recumbent hair, its ventral surface with somewhat longer hair. The spinnerets form a rosette and seem to be typical, but somewhat damaged. The epigynum (Fig. 164) is prominent, transversely ellipsoidal, flanked by long, converging hairs. The palp has a claw, but its structure is obscured by white emulsion.

*Eodipoena bassleri* n. sp. Plate XLIX, Figs. 461 to 464, Plate LXIX, Fig. 617. (Named in honor of Dr. R. S. Bassler.)

Type. Mature female. One specimen in the collection of the U. S. National Museum, Washington, D. C.

Originally the specimen must have been in a piece of clear amber with a plane of cleavage passing more or less symmetrically through the spider. What has happened to the right side of the spider I do not know. Perhaps the piece of amber split in the process of mining and the two pieces became separated. At any rate only the left side of the spider is present in the piece belonging to the U. S. Nat. Museum. Of the carapace approximately one third is left including what seem to be the two lateral eyes. The sternum is complete. Both chelicerae, both maxillae and the lip are also undamaged. Of the abdomen the entire left half, the epigynum and the complete spinning group are present. All legs and the palp of the left side are intact except for the fourth tarsus which is incomplete. The retrolateral surface of the legs is covered with brown emulsion which however does not obscure the view.

Total length 4.0 mm. The carapace is 1.8 mm. long. Its width and height cannot be measured. Nor is it possible to give an approximate calculation on the basis of partial measurement because it is not possible to determine its actual shape. The abdomen is ovoid, 2.0 mm. long and ca. 1.4 mm. high, measured in a straight line, from the dorsal surface to an imaginary line extending from the petiolus to the spinnerets. Because of the position of the legs a sideview of the carapace is not possible. One can only look into the cavity of the cephalothorax.

The chelicerae are visible in three positions, from in front, from below and from inside. A portion of the clypeus is also visible including what may be the left lateral eye. If measured to the lower edge of this eye the height of the clypeus is 0.28 mm., while the length of the basal joint of the chelicerae is 0.52 mm. In other words, compared with the chelicerae the clypeus is rather high. The chelicerae are parallel, apparently without a boss, but with slightly concave anterior surface which is very sparsely clothed with short hair. This hair is coated with white emulsion. When examined in strong, transmitted light it appears to be of dark color. A white, sausage-shaped accumulation of white emulsion sticking out of the mouth of the spider obstructs the view of the margins of the chelicerae.

The maxillae (Fig. 461) are also partly covered by emulsion, but can be seen in certain positions. They are slightly converging without meeting in the middle line. Their outer edge is rounded and the palp is attached near the base. The free surface of the maxillae is clothed with short hair. The lip is free, wider than long, reaching only to the middle of the maxillae. The sternum is clearly visible from below and from inside. It is more or less triangular; wide and somewhat concave in front, bluntly pointed behind, longer than wide in ratio 25:19. Its sides are distinctly angular. Its surface is clothed with numerous short, stiff hairs. The first coxae are wide apart. The right leg is missing, but owing to the position of the left coxae one may say that the fourth coxae must have been separated by at least half their width. The coxae are clothed in the same manner as the sternum. The trochanters are not notched.

Leg formula	1	4	2	3
	2.8	2.7	2.5	2.0

	Femur	Pat. + Tib.	Metat.	Tarsus	Total
I	1.60	1.60	0.96	0.80	4.96
II	1.48	1.40	0.88	0.72	4.48
III	1.12	1.20	0.68	0.64	3.64
IV	1.60	1.72	0.88	(?)0.68	4.88

The legs are sparsely clothed with rather long, stiff, bristle-like hair. True spines are wanting. Especially noticeable are the usual dorsal fine bristles 0-1 on the patella and 1-0 on the tibia. In addition to this hair which is inclined forward, there are present on all legs, but especially on those of the first and second pair short, erect, stout hairs (Fig. 464) separated from each other by more or less regular intervals. There is no scopula on any leg. The claws are difficult to see, but there are three of them and the upper claws seem to be provided with teeth.

The palp is clothed with the same type of hair as the legs. Its terminal joint is with a claw.

The abdomen is clothed with fine brown hair of a simple kind except on the sides of the epigynum (Fig. 463) where there are six or seven incurved bristles on each side. The epigynum itself is dark brown, transversely ellipsoidal and fairly prominent. Six spinnerets (Fig. 463). The first pair is contiguous, stout, conical. The median pair is small and slender. The posterior pair is some-



what shorter and more slender than the first pair. Colulus well developed. Anal tubercle as long as the posterior spinnerets.

Genus *Nactodipoena*, nov.

With the characters of the family and subfamily except that the tarsal comb is less developed being composed of only seven bristles. Carapace very high and almost circular with flat head. Eyes in two rows. PME smallest. Quadrangle wider in front than behind. Eyegroup much narrower than the head. Sternum convex, almost as wide as long. Its posterior end transversely truncated between the hind coxae. First coxae wide apart. Upper claws curved, with three small teeth. Type *N. dunbari* n. sp.

(Derivation of the name: Latin—nactus, from nanciscor—to find.)

*Nactodipoena dunbari* n. sp. (Plate LXIX, Fig. 627; Plate LI, Figs. 475 to 483). Named in honor of Dr. Carl O. Dunbar.

A single specimen No. 7 in the collection of the Peabody Museum, Yale University.

Type. Mature male. The spider is in perfectly clear amber except for some emulsion on the ventral surface of the abdomen. The piece has a concave surface close under which the spider is situated. The first left leg was lost in life. All other legs are complete. The color of the chitin is dark brown. The abdomen is somewhat lighter.

Total length 2.3 mm. Carapace 1.0 mm. long, 0.84 mm. wide in middle. It has a peculiar shape (Figs. 475-477) being almost round in circumference with the eyegroup projecting in front. The head is delimited by a semicircular groove from which three pairs of thoracic grooves radiate. These extend to the edge of the flat area. In side view the carapace appears very high, so that it gives the impression of a cylinder. The posterior declivity is very steep. The thoracic groove is longitudinal. The head is slightly convex, a little elevated above the semicircular flat area. The eyegroup is transversely ellipsoidal, slightly inclined forward. The total width of the eyegroup is 0.41 mm., *i. e.* much less than the width of the face. The sides of the face are almost vertical, the clypeus is very high. The quadrangle is wider in front than behind. The lateral eyes are contiguous, but all other eyes are

clearly separated. The PME are smaller than the AME, but no measurements are possible on account of reflections caused by the peculiar shape of the piece. The entire surface of the carapace is glabrous.

The view of the chelicerae is obstructed by the right palp, but judging by the general proportions of the head and maxillae we may assume that the chelicerae are quite small, probably no longer than the maxillae. The maxillae (Fig. 478) are strongly inclined over the lip. The palp is inserted near their base. The lip is wider than long, rounded in front, with a procurved sternal suture. The sternum is convex, slightly longer than wide, more or less suddenly constricted between the hind coxae, forming as it were a rectangular projection between the latter. The posterior end is transversely truncated. The surface of the sternum is glabrous. The first coxae are wide apart, the fourth coxae separated by about their width.

Leg formula	4	1	2	3	
	2.5	2.3	2.0	2.0	
	Femur	Pat. + Tib.	Metat.	Tarsus	Total
I	0.72	0.79	0.46	0.29	2.26
II	0.67	0.67	0.36	0.29	1.99
III	0.60	0.70	0.36	0.29	1.95
IV	0.82	0.89	0.46	0.31	2.48

The legs are clothed with simple hair which is almost as long as the bristles of which one may recognize the usual dorsal 1-1 on the patella and dorsal 1-1 on the tibia. True spines are wanting. Serrated bristles are present on all tarsi. The fourth tarsus (Fig. 482) is provided with a comb which, while unmistakable, is not very well developed and consists of only seven serrated bristles. Trichobothria few. There is a row of three on the tibia and a single trichobothrium in the middle of the metatarsus.

Three claws. Upper claws similar, with three small teeth visible only under high power (Fig. 479). Third claw curved, with a single small tooth.

The abdomen is ovoid with posterior end more pointed. It is 1.4 mm. long, 1.0 mm. wide in middle. It is sparsely clothed with short hair visible only under higher power. The ventral surface is coated with white emulsion through which the spinnerets are sufficiently visible to appear as typical of the family.

The palp has a rather thin and long femur (Fig. 481). The terminal joint is unusually large, while the tibia is small and wider than long. The embolus is sickle-shaped, situated in the middle of the bulb on the retrolateral surface of the latter.

Subfamily *Asageninae*

Genus *Steatoda* Sundevall, 1833

Type: *S. bipunctata* (Linnaeus)

I refer to this genus two specimens one of which is a mature female and the other an immature male. Both seem to belong to the same species, but their generic affiliation is not quite certain because some of the characters cannot be seen.

*Steatoda succini* n. sp. Plate LXIX, Figs. 622 and 623. Plate L, Figs. 470 to 474. Plate LIII, Figs. 499 to 502. Plate LIV, Fig. 503.

Type. Mature female in the collection of Cornell University, No. 3. The specimen is in perfectly clear amber, but there is a plane of cleavage, the two halves having been cemented by a previous owner. The color of the chitin in the cephalothorax and its appendages is dark brown. That of the abdomen a light yellowish grey. There are on its dorsal surface four brown discs forming a trapeze representing dorso-ventral muscle attachment discs usual in spiders.

Total length 1.8 mm. The carapace is to a considerable extent obstructed from view by the right legs and by the anterior edge of the abdomen. Its shape can be only guessed, its measurement is very difficult. Approximate length 0.7 mm. Maximum width representing double the distance from the edge of the carapace to the thoracic groove 0.6 mm. The carapace is narrowed in front to the width of the eyegroup so that one gets the impression of a rather pointed anterior end. Of the eyes only the anterior median pair is visible. A little of the eyegroup may be seen from its left side. In this position the eyegroup appears to be the highest point of the carapace. The view of the clypeus and of the chelicerae is obstructed. The ventral surface is clearly visible (Fig. 470). The lip is wider than long. The maxillae are

strongly converging, but do not meet in the middle line. The sternum is more or less triangular with rounded sides. The first coxae are very far apart, the fourth coxae are separated by their width. The legs are fairly stout and short.

Leg formula	4	1	2	3
	3.4	3.0	2.7	2.7

	Femur	Pat. + Tib.	Metat.	Tarsus	Total
I	0.70	0.70	0.38	0.31	2.09
II	0.62	0.62	0.34	0.31	1.89
III	0.62	0.62	0.34	0.31	1.89
IV	0.74	0.82	0.43	0.36	2.35

(NB. The length of the second femur cannot be measured. It is given here as equal to the third femur because the entire second leg has the appearance of being equal to the third leg.)

Width of first patella 0.096 mm. First tibial index 13.7.

Width of fourth patella 0.096 mm. Fourth tibial index 11.7.

The legs are clothed with long, bristle-like hair. True spines are wanting, but there are the usual dorsal bristles 1-1 on the patella and 1-1 on the tibia. Serrated bristles on the fourth tarsi form a primitive comb (Fig. 471). The first tarsus is cylindrical, but the others are tapering almost to a point. Trichobothria in two rows on tibiae, in one row on metatarsi and tarsi. Three claws (Fig. 472). Upper claws similar, curved, comparatively small, with a row of eight teeth. Third claw smooth.

Abdomen ellipsoidal, flattened above, 0.79 mm. long, 0.62 mm. wide. On the dorsal surface the usual four attachment discs of the dorsoventral muscles are plainly visible and form a trapeze which is narrower in front than behind and slightly wider behind than long in ratio 17:15. The back of the abdomen is sparsely clothed with short brown hair and has a metallic appearance. The spinnerets form a rosette, but their view is partly obstructed by the fourth left leg. The epigynum (Fig. 474) is clearly visible and has the shape of a round chitinous disc through which the two receptacles are visible. These open into a transversely ellipsoidal opening to the outside just above the genital fold.

The palp has a claw (Fig. 473) the structure of which cannot be seen on account of the position of the appendage.

The spider has the general appearance of an Argiopid rather than a Theridiid and may be easily mistaken for one. But the Theridiid nature is evidenced by the inclined maxillae, plain lip not rebordered, relative proportions of the legs, presence of a tarsal comb and structure of the claws.

*Description of Specimen No. 3602 of the Peabody Museum.*

Immature male. Color of chitin light rufous with a golden sheen. The legs are drawn up in such a position that they hide the carapace. The total length can therefore be given only approximately as 1.6 mm. The chelicerae (Fig. 501) are visible from in front. They are parallel and rather slender. The margins are transverse and the promargin ends in a single tooth. The fang is short, slender and curved a little. The lip (Fig. 503) is wider than long, with rounded anterior end and a straight suture. The maxillae are strongly inclined over the lip and the palps are inserted at their base. The sternum is shiny, golden in color, with few scattered fine hairs. The sternum is more or less triangular, longer than wide in ratio 10:9, widely truncated in front, slightly convex. The first coxae are far apart, the fourth coxae are separated by more than half their width.

Order of legs 4123.

	Femur	Pat. + Tib.	Metat.	Tarsus	Total
I	0.74	0.74	0.41	0.36	2.25
II	0.70	0.70	0.38	0.24	2.02
III	0.58	0.48	0.29	0.38	1.73
IV	0.66	0.74	0.43	0.43	2.26

Width of the first patella 0.120. First tibial index 16.

Width of the fourth patella 0.120. Fourth tibial index 16.

True spines are wanting. The legs are clothed with fairly long stiff hair. The usual bristles are present on the patella dorsal 1-1, and on the tibia dorsal 1-1. The tarsal comb (Fig. 499) is composed of seven serrated bristles and is well developed.

Three claws (Fig. 502). Upper claws similar, bent, with a row of 6 or 7 teeth increasing in length distally. The third claw is long and fine, with a single tooth. At least one serrated bristle is present under the claws. The trichobothria are difficult to see on account of the position of the legs.

The abdomen is ellipsoidal, somewhat flattened above, 0.86 mm. long, 0.90 mm. wide (slightly wider than long), clothed with stiff, fairly long brown hair, each hair sitting in the center of a little, darker colored disc. The ventral surface of the abdomen shows longitudinal lateral plications. The spinnerets (Fig. 500) form a regular rosette. The anterior spinnerets are stouter and longer than the posterior ones. The median spinnerets are minute, though clearly visible. The colulus is well developed.

The palpi have a distinctly swollen terminal joint showing that the specimen is a male in the penultimate instar.

It is difficult to say whether the difference in the structure of claws is sufficient to separate this specimen from the Type female described above. The two spiders look a great deal alike. It seems reasonable in view of the immaturity of the male to refer it to the same species.

#### Subfamily *Mysmeninae*

I place in this subfamily the two new fossil Genera *Municeps* and *Eomysmena*. They can be differentiated from each other and from recent genera by the following characters.

1. Upper claws bent, with a single tooth. Third claw bent at right angles, with a single tooth. Lip more than twice as wide as long. Order of legs 4123. All eyes equal ..... *Municeps*.
- \* Upper claws evenly curved, smooth. Third claw smooth. Lip less than twice as wide as long. Order of legs 1423. PME smaller than the other eyes .. *Eomysmena*.

#### Genus *Municeps*, nov.

Carapace rather flat and considerably narrowed down anteriorly. First row of eyes recurved, second row almost straight. All eyes equal, those of the first row very little separated from each other, those of the second row separated by their diameter. Quadrangle wider behind than in front and wider than long. Clypeus ca. one and one half times as high as the quadrangle. Maxillae strongly inclined over lip. Lip more than twice as wide as long. Sternum triangular, as wide as long. Order of legs 4123. Tarsi longer

than metatarsi. Spines wanting. Comb composed of about seven bristles. Upper claws bent, with a single small tooth. Third claw bent at right angles, with a tooth. Six spinnerets. Colulus well developed. Palp inserted at base of maxilla, with a claw. Type *M. pulcher*.

(Derivation of name: Latin—municeps—an inhabitant.)

*Municeps pulcher*, n. sp. Plate LVIII, Fig. 540. Plate VIII, Figs. 73 to 75. British Museum, Seeborn's Bequest, In. 17660.

Type. Pullus. Specimen in perfectly clear amber containing also five mites partly obstructing the view of the head. Color of the chitin reddish brown, legs rufous, abdomen silvery white. Spinnerets light rufous.

Total length 1.8 mm. Carapace 0.8 mm. long, 0.67 mm. wide opposite second coxae where it is widest, narrowed down in front almost to the width of the eyegroup. No trace of a thoracic groove. The surface of the carapace is glabrous. The eyes are quite prominent. Although the head is as high as the thorax at its highest point, the sides of the head are very clearly delimited by the cephalothoracic sulci. Consequently the head looks in some positions almost as if it were elevated like a turret. The eyes add to this illusion because they protrude beyond the clypeus. Unfortunately the presence in the amber of the above mentioned mites prevents a clear view of the head.

The eyegroup is typical of the family. The first row is recurved, the second row so slightly recurved that it is almost straight. The width of the eyegroup is 0.30 mm. The quadrangle is wider behind than in front in ratio 8:7, wider than long in ratio 8:6. All eyes are of the same size. Anterior eyes are rather close together. Lateral eyes are contiguous. Posterior eyes are separated by about their diameter. The clypeus is concave and very high. The ratio of its height to the length of the quadrangle is 10:6. Expressed in millimeters the height of the clypeus is 0.24 mm.

The chelicerae are rather short and parallel. Their structure cannot be seen because the maxillae obstruct the view. The maxillae are very large (Fig. 73) and so strongly inclined over the lip that they almost meet in the median line. A long serrula is visible on their anterior edge. The lip has almost the shape of a crescent with both edges recurved. It is more than twice as wide as long.

The sternum is distinctly convex, triangular, as wide as long. The first coxae are wide apart. The fourth coxae are separated by about their width.

Leg formula	4	1	2	3
	2.5	2.2	1.9	1.7

	Femur	Pat. + Tib.	Metat.	Tarsus	Total
I	0.60	0.62	0.22	0.28	1.72
II	0.55	0.47	0.24	0.29	1.55
III	0.41	0.45	0.22	0.29	1.37
IV	0.65	0.65	0.31	0.36	1.97

Width of first patella 0.144 mm. First tibial index 23.

Width of fourth patella 0.132 mm. Fourth tibial index 20.

Legs rather short and stout, without spines. There is a dorsal apical bristle on the patella and a dorsal bristle on the tibia. The comb is visible on the left fourth tarsus, the corresponding right tarsus being so turned that the comb cannot be seen. The comb is composed of about seven short, serrated bristles. The trichobothria are difficult to see. There are three on the first tibia and three on the first metatarsus. Three claws. Upper claws similar, slightly bent in middle (Fig. 75) with a single tooth. Third claw as long as the upper claws, bent at right angles, with a single tooth. There is at least one serrated bristle visible under the claws.

The palp is inserted at the base of the maxilla and has a claw of the same type as the upper tarsal claws.

The abdomen is ellipsoidal, somewhat flattened above and considerably overhanging the carapace. It is 0.64 mm. long, 0.59 mm. wide. It is sparsely clothed with comparatively short bristles each sitting in the center of a little dark disc. These bristles are present also on the sides of the abdomen, but not on the ventral surface. The spinnerets are very well preserved (Fig. 74). They occupy with the anal tubercle an almost perfectly circular area. The anterior spinnerets are cone-shaped, contiguous. The posterior pair is of the same size and shape as the anterior pair, but their bases are wide apart. The median spinnerets are very small. The colulus is large, cone-shaped.

#### Genus *Eomysmena*, nov.

Carapace with head considerably elevated, greatly narrowed in front. First row of eyes very strongly recurved, second row dis-



tinctly recurved. PME slightly smaller than the other eyes. Eyes of first row separated by a little more than their radius. PME are separated by one and one half their diameter. They are wider apart from each other than from the PLE. Lateral eyes contiguous. Quadrangle wider behind than in front, wider than long. Clypeus vertical, concave, more than twice as high as the quadrangle. Lip wider than long. Sternum triangular, a little longer than wide. Order of legs 1423. Tarsi longer than metatarsi. Spines wanting. Comb composed of about seven bristles. Upper claws curved, smooth. Third claw smooth. Six spinnerets. Colulus present. Type *E. moritura*.

*Eomysmena moritura*, n. sp. Plate LXV, Fig. 591. Plate XXVIII, Figs. 259 to 266.

British Museum, Collection from Samland, In. 18113.

Type. Male. The specimen is in dark yellow amber which is still darker around each leg. An air-bubble somewhat obstructs the view of the right side of the spider, in its anterior portion. The previous owner polished off the ends of almost all legs and of the dorsal surface of the cymbium. Only the first and second right tarsi remain. The color of the chitin is greyish brown. The abdomen is somewhat lighter. The ventral surface of the abdomen is coated with white emulsion.

Total length 3.8 mm. Carapace 1.88 mm. long, 1.60 mm. wide between second and third coxae where it is widest. It is narrowed down anteriorly almost to a point. The head is considerably elevated above the thorax (Fig. 260) with the AME protruding beyond the clypeus and the lateral eyes beyond the sides of the head. Deep sulci converging on an almost circular thoracic groove clearly delimit the head (Fig. 259).

The eyegroup is 0.60 mm. wide and the second row of eyes is slightly wider than the first row. The latter is so strongly recurved (Fig. 261) that the ALE form almost a straight line with the PME. The posterior row is also recurved, but not nearly as much. The ratio of eyes is AME:ALE:PME:PLE = 5:5:4.5:5. The quadrangle is wider behind than in front in ratio 14.5:13 and wider than long in the same ratio. The AME are on a common tubercle, but there is a deep depression between them. The AME are separated from the ALE by a still deeper depression.

The eyes of the first row are equidistant, separated from each other by three-fifths of their diameter. The lateral eyes are contiguous. The PME are separated from each other by  $7/4.5$  of their diameter and from the ALE by the diameter of the latter. The clypeus is very high, slightly concave under the AME, then almost vertical, but slightly inclined forward. It is equal to 0.76 mm. (Fig. 262), *i. e.* two and one-half times as high as the quadrangle. The middle of the clypeus is covered with about six vertical rows of long, stiff bristles directed inward.

The chelicerae are appreciably shorter than the height of the head. They are parallel, short and stout, but yet the two together are not as wide as the maxillae. A boss seems to be wanting. Of the fangs and the margins nothing can be seen.

The view of the maxillae and lip is partly obstructed by emulsion and by the first right tarsus. Their probable shape is shown by the dotted lines in Fig. 263. From in front the serrula is visible and the entire front edge of the maxillae can be seen. The sternum is more or less triangular, longer than wide in ratio 15:14, fairly flat and clothed with stiff hair. The first coxae are wide apart. Although the view of the right fourth coxa is obstructed by emulsion, one can judge the separation of the fourth coxae by the position of the left coxa. They are separated by about half their width. Probable order of legs 1423.

	Femur	Pat. + Tib.	Metat.	Tarsus	Total
I	1.80	1.88	1.00	0.68	5.36
II	1.48	1.60	0.96	0.68	4.72
III	1.20	...	...	...	...
IV	1.60	1.60	...	...	...

Spines wanting. Legs clothed with stiff hair. Three claws. Upper claws curved, smooth. Third claw as long as upper claws, slightly bent, smooth (Fig. 266). Claw-tufts and scopulae wanting. No trichobothria can be seen.

The abdomen (Fig. 259) is truncated in front, rounded behind and somewhat wider than the carapace. It is 2.0 mm. long, 2.1 mm. wide, sparsely clothed with stiff hair. The spinnerets are partly injured, a portion of them having been polished off by the previous owner. Enough is visible to show that they are arranged in a rosette. The anterior spinnerets are cone-shaped, contiguous. The posterior pair is also cone-shaped and contiguous. The median

pair is very small. A small colulus is present. The terminal joint of the anterior and posterior spinnerets is hemispherical.

The palp (Figs. 264 and 265) has an unusually long and distinctly curved femur. It is more slender than the patella. The tibia widens in front forming an outer apophysis. The cymbium is black. The structure of the bulb may be best understood from the figure.

*Eomysmena succini* n. sp. Plate LXVII, Fig. 606. Plate XXXVI, Figs. 341 to 346.

British Museum, Collection from Samland, In. 18114.

A very perfectly preserved specimen in clear amber. There is some emulsion around the mouthparts and on the ventral surface. The color of the chitin of the carapace light rufous, of the legs and abdomen greyish rufous.

Type. Immature male in penultimate instar. Total length 1.7 mm. Carapace, 0.89 mm. long, measured from the side because its posterior end is overhung by the abdomen, 0.77 mm. wide between second and third coxae where it is widest, narrowed down in front (Fig. 341) to the width of the eyegroup which is 0.31 mm. It is rather flat, with the head on a level with the thorax. AME are on a common tubercle. The lateral eyes on each side of the head are also on a common tubercle. The first row of eyes is strongly recurved, the second row is also recurved, but much less. All eyes are of about the same size, the lateral ones somewhat smaller than the median ones. The quadrangle is about as wide as long (Fig. 343). The clypeus (Fig. 344) if measured to the lower edge of the eye-tubercle is as high as the quadrangle, but if measured to the lower edge of the AME is distinctly higher than the quadrangle. The thoracic groove has the shape of a triangular depression with the apex directed forward. The carapace is glabrous and shiny. In a lateral view one can see four bristles on the head, but nowhere else.

Chelicerae, mouthparts and part of the sternum are covered with an emulsion. Of the sternum a sufficient portion is visible to give a clear idea of its shape. It is triangular, very wide in front, distinctly convex and shiny. First coxae wide apart. Fourth coxae separated by their width.

Leg formula	1	4	2	3		
	2.7	2.6	2.3	2.0		
	Femur	Pat. + Tib.	Metat.	Tarsus	Total	
I	0.79	0.79	0.41	0.41	2.40	
II	0.62	0.72	0.34	0.36	2.04	
III	0.53	0.53	0.29	0.34	1.69	
IV	0.70	0.77	0.41	0.46	2.34	

Width of first patella 0.120 mm. First tibial index 15.

Width of fourth patella 0.120 mm. Fourth tibial index 15.5.

Spines wanting, but the usual dorsal bristles are present 0-1 on the patella and 1-1 on the tibia. The legs are sparsely clothed with stiff hair almost as stout as the bristles. A well developed comb (Fig. 242) is present on the fourth tarsi, but no serrations can be seen on the bristles of which it is composed. Three claws. Upper claws similar, gently curved, smooth. Third claw as long as the upper claws, (Fig. 345) smooth, becoming rapidly slender from the middle on. Claw-tufts and scopulae are wanting.

Abdomen (Fig. 341) almost circular, 1.1 mm. long, 1.0 mm. wide. It is slightly flattened above and is clothed with rufous bristles each sitting in the center of a rufous disc. Six spinnerets forming a rosette are somewhat obscured from view by emulsion.

#### Family *Adjutoridae*, nov.

The creation of this new family is necessitated by a combination of characters not found in any of the known recent families. Although the structure of the heart and of the tracheal system remains unknown the probability is in favor of a relationship with the Trionychae, rather than with the Quadrostitatae, still less with the Apneumonomorphae. I refer three genera, all new, to the Family *Adjutoridae*. *Adjutor* and *Admissor* form the Subfamily *Adjutorinae*; and *Adjunctor* is by itself in the Subfamily *Adjunctorinae*. Each genus is represented by a single specimen. Unfortunately these three specimens are immature, a situation which complicates matters because it is impossible to decide to which instar they belong. From the third instar on, the family characters are usually well recognizable. In the second instar some structures are still poorly developed though already recognizable. In the first instar familial characters are sometimes still wanting as I have shown in the case of *Phormictopus cancerides*. Such observa-

tions apply of course to recent spiders, but it is probable that the same condition prevailed in amber spiders. The family must be therefore regarded as only provisional and may have to be later reduced to the rank of a subfamily when more material is available.

The most striking characters of the new family are the extraordinary length of the trichobothria and the relative size of the spinnerets. The trichobothria while not numerous are longer than in any recent or fossil spider known to me. Of the six spinnerets the anterior pair are by far the stoutest, reaching the greatest difference in *Adjutor mirabilis*. The colulus is well developed and the anal tubercle is cone-shaped, large and two-jointed. The carapace is low. The eight round eyes are arranged in two rows. The chelicerae are with oblique margins, without a boss. The maxillae are very thick and slightly inclined over the lip which is free and wider than long. The sternum is very convex and broadly rounded behind. Legs with spines, but without scopulae, claw-tufts or serrated bristles. The hair is simple. Three claws. The third claw well developed in the Subfamily *Adjutorinae*, reduced to a thorn in the Subfamily *Adjunctorinae*. The upper claws are similar, pectinate in a single row.

#### Key to Subfamilies

1. A single trichobothrium on all tibiae and metatarsi.  
Sternum broadly rounded behind. Third claw well developed, bent at right angles ..... *Adjutorinae*.
- \* Several trichobothria on all tibiae and metatarsi. Sternum subtriangular with rounded posterior end. Third claw reduced to a thorn ..... *Adjunctorinae*.

#### Subfamily *Adjutorinae*

##### Key to Genera

1. Anterior spinnerets much stouter than the posterior ones.  
Head with two pairs and a single fifth long bristle.  
Spines on legs few. Claws small and stout ... *Adjutor*.
- \* Anterior spinnerets not much stouter than the posterior ones. Head without bristles. Spines on legs fairly numerous. Claws long and slender. .... *Admissor*.

#### Genus *Adjutor*, nov.

Carapace low. Head on the same level with the thorax, with five long bristles directed forward and arranged in two pairs and

a single bristle behind the others and immediately in front of the thoracic groove. Eight eyes in two rows, both rows gently recurved. Quadrangle wider behind than in front. AME smallest. Lateral eyes contiguous. Eyegroup full width of the head. Chelicerae stout and short, with short fangs. Maxillae slightly inclined over lip. Palp inserted at anterior outer angle. Lip wider than long, distinctly thickened at end. Sternum longer than wide, gradually and evenly rounded behind. First coxae wide apart. Fourth coxae separated by more than their width. Trochanters not notched. Spines few. One trichobothrium of great length on all tibiae and one on all metatarsi. Claws small but stout. Third claw bent at right angles. Anterior spinnerets cone-shaped, contiguous, very stout and considerably longer than the posterior ones which are slender and cylindrical. Type *A. mirabilis*. (Derivation of name: Latin—adjutor—a helper.)

*Adjutor mirabilis* n. sp. Plate LXVII, Fig. 607. Plate XXXI, Figs. 290 to 299.

British Museum, collection from Samland, In. 18945.

Type. Immature female. A well preserved specimen in fairly clear amber. Color of chitin brown.

Total length with spinnerets 1.32 mm. Carapace 0.57 mm. long, 0.48 mm. wide between second and third coxae where it is widest. It is comparatively little narrowed in front (Fig. 290) where it measures just behind the eyes 0.37 mm. The eyegroup is slightly wider than the head, so that the lateral eyes appear protruding beyond its sides. Eight eyes in two rows. First row recurved and somewhat shorter than second row which is so slightly recurved that it may be said to be straight. The quadrangle is wider behind than in front in ratio 8.5:5.5, wider than long in ratio 8.5:6. Ratio of eyes AME:ALE:PME:PLE = 2:3.5:3:3.5. AME separated from each other by their diameter and by almost the same distance from the ALE. PME are separated from each other by slightly more than their diameter and are farther apart from each other than from the PLE. The lateral eyes are contiguous, on a common tubercle. There is a slight depression in the place of the thoracic groove. Immediately in front of this depression a median bristle is situated and in front of this two pairs of bristles form a rectangle. Except for these bristles which are conspicuous by their length and are directed forward the carapace is glabrous

(Fig. 295). The posterior declivity is rather steep. The clypeus (Fig. 292) is vertical and about as high as the quadrangle. Viewed from in front the first row appears to be almost straight, the second row downcurved. There are two light-colored bristles on the quadrangle, one on each side between the AME and PME.

The chelicerae are well visible from below (Fig. 291). They are short and stout, apparently without boss. The fangs are short and rather stout, gently curved. They are shorter than the width of the basal joint of chelicerae. The margins are almost transverse. The promargin is with a sparse scopula. The retromargin is also visible, but it is impossible to say whether it is armed or smooth. The lip is wider than long, free, with a procurved suture and distinctly thickened anterior edge. The maxillae are very thick. Anteriorly they are separated from each other by considerably less than the width of the lip and their anterior edge is transverse. As a result they appear to be slightly inclined over the lip as shown in Fig. 291. The palp is inserted in the antero external angle in a little excavation the base of which is slightly behind and parallel to the anterior edge. There is no maxillary scopula visible. The sternum is very convex and longer than wide. Anteriorly it is as wide as the combined width of the maxillae and lip. The sides are gradually converging in a curve so that there is no distinct posterior margin present, the sternum being evenly rounded between the hind coxae which are separated by more than their width. The first coxae are very far apart. All coxae are of about the same size. None of the trochanters are notched.

Leg formula	1	2	3	4		
	2.4	2.3	2.3	2.2		
	Femur	Pat. + Tib.	Metat.	Tarsus	Total	
I	0.43	0.43	0.24	0.24	1.34	
II	0.38	0.43	0.24	0.24	1.29	
III	0.35	0.46	0.24	0.24	1.29	
IV	0.35	0.43	0.26	0.24	1.28	

Width of first patella 0.096 mm. First tibial index 22.

Spines few, long and fine. First leg. Femur dorsal 0-1-1. Patella dorsal 1-1. Tibia dorsal 1-1. Metatarsus prolateral 1, retrolateral 1. There are no spines elsewhere on this leg. Second leg same as first, but the spines on the patella are longer and there is present a long retrolateral bristle on the tibia. Third leg.

Femur dorsal 0-1-1. Patella dorsal 1-1. Tibia dorsal 1-1. Metatarsus dorsal 0-1, ventral 0-2. There are no spines elsewhere on this leg. Fourth leg same as third except for the presence of a spine on the retrolateral surface of the tibia, not far from its base.

Three claws. Upper claws (Fig. 293) similar, curved, small and rather stout, with a row of six or seven teeth. Third claw bent at right angles, smooth. There is very little hair on the legs and such as there is is of the simple kind. Trichobothria are few, but unusually long (Fig. 298). There is one on each tibia a little beyond the middle and one on each metatarsus beyond the dorsal spine. The relative length of these trichobothria is best understood from a comparison of measurements. The fourth tibia is 0.252 mm. long while the trichobothrium is ca. 0.288 mm. The fourth metatarsus is 0.240 mm. and the metatarsal trichobothrium 0.306 mm. On some of the tarsi one can see near the claws some bristles which may be very finely serrated, but this cannot be definitely established. Claw-tufts and scopulae are wanting. The palp (Fig. 299) has also a few bristles and spines. The terminal joint has a slender, smooth claw.

The abdomen (Fig. 294) is transversely truncated in front, with more or less parallel sides in the anterior three quarters, then rapidly converging to a point. Measured without spinnerets the abdomen is 0.62 mm. long, 0.46 mm. wide. The surface of the posterior third of the abdomen is traversed by recurved transverse grooves which are directed forward as they reach the sides. These grooves probably are remnants of segmentation. The anal tubercle is cone-shaped, two-jointed. The ventral surface of the abdomen presents besides the genital fold another transverse fold half way between the former and the spinnerets. Since the genital opening in all Arachnida is on the second abdominal somite, the third somite represents either the second pair of lungs as in *Mygalomorphae*, or the tracheal spiracles as in *Arachnomorphae*. The spinnerets are so well preserved that they can be studied under high power. The anterior spinnerets are large (Fig. 296), stout, cone-shaped, contiguous at base, with a small hemispherical terminal joint. It bears two large spigots. The median spinnerets are cylindrical, slender, small, each with two common spinning tubes. The posterior spinnerets are cylindrical, much more slender than the anterior ones, scarcely longer than the median pair. They are separated from each other by the anal tubercle and each has on



its terminal joint a pair of common spinning tubes. Thus the entire spinning apparatus consists of 12 spinning tubes, four of which are spigots. A small colulus is present in front of the anterior spinnerets.

Genus *Admissor*, nov.

Carapace with shoulder humps on sides of thoracic groove, sloping downward anteriorly. Eight eyes in two rows, both very slightly recurved. Eyes about equal and quadrangle square. Eye-group full width of head. Chelicerae with oblique margins. Retromargin with two teeth. Maxillae parallel. Palps inserted at their base. Lip free, wider than long, not thickened at end. Sternum convex, evenly rounded behind, truncated in front, as wide as long. First coxae wide apart, fourth coxae separated by more than their width. Trochanters not notched. Spines fairly numerous. One long trichobothrium on every tibia, metatarsus and tarsus. Claws slender and long. Third claw bent at right angles. Anterior spinnerets cylindrical, stouter and longer than the posterior pair, contiguous. Type *A. aculeatus*.

(Derivation of name: Latin—admissor—a perpetrator.)

*Admissor aculeatus*, n. sp. Plate LXIV, Fig. 586. Plate XXXIII, Figs. 312 to 322.

British Museum, collection from Samland, In. 18946.

A well preserved specimen in rather dark amber. A bubble of air and several reflecting surfaces make the study somewhat difficult. On the other hand there is no emulsion to obstruct the view. All appendages are complete and the mouthparts are clearly visible. Color of chitin very dark brown.

Type. Immature female. Total length including chelicerae and spinnerets 2.47 mm. Carapace ca. 0.8 mm. long, ca. 0.6 mm. wide. The study of the carapace is complicated by the fact that the abdomen is turned in a manner making neither a dorsal, nor a lateral view of the carapace possible. The best way to study it is to place the piece of amber in such a position that the abdomen presents its right side, while the cephalothorax presents a three-quarter view of the face. At the same time the beam of light should be lowered until it strikes not the surface of the piece of amber, but the carapace itself. Viewed in this position the thoracic

groove appears as a depression with a pair of shoulder humps. These humps represent the highest point of the carapace. The posterior declivity is fairly steep. Anteriorly the carapace slopes in a gentle curve toward the eyegroup. The head is clearly delimited by the cephalothoracic sulci and bears a row of long, curved bristles. The eight eyes are of about equal size and form two slightly recurved rows. The four median eyes are separated from each other by about their diameter and form a square quadrangle. The clypeus is about as high as the quadrangle.

The chelicerae are parallel, fairly long, with oblique margins. The retromargin has two pointed teeth at its proximal end. The promargin is smooth. There is no scopula on either margin. The fang is stout at the base, strongly curved and quite pointed. The maxillae are more or less parallel, thick, convex below and much wider in front than at base. There is a scopula at the end. The palp is inserted near the base of the maxilla (Fig. 319). The lip (Fig. 312) is free, wider than long, evenly rounded and not thickened in front. The sternum is convex, widely truncated in front, evenly rounded behind, as long as wide, glabrous. The first coxae are wide apart, the fourth coxae are separated by more than their width. None of the trochanters are notched.

Leg formula	$\frac{2}{3.6}$	$\frac{1}{3.4}$	$\frac{4}{3.4}$	$\frac{3}{3.4}$
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	Femur	Pat. + Tib.	Metat.	Tarsus	Total
I	0.80	0.80	0.68	0.44	2.72
II	0.88	0.88	0.68	0.44	2.88
III	0.80	0.88	0.64	0.40	2.72
IV	0.80	0.80	0.72	0.40	2.72

Width of first patella 0.120 mm. First tibial index 15.

Width of fourth patella 0.120 mm. Fourth tibial index 15.

Spines fine and long, standing out at right angles. First leg. Femur dorsal 1-1-0, elsewhere 0. Patella dorsal 1-1, elsewhere 0. Tibia dorsal 0-1, prolateral 1-0, retrolateral 1-0, ventral 1p-2-0. Metatarsus dorsal 1-1-0, prolateral 1-0-1, retrolateral 1-0-1, ventral 2-2-2. Second leg same as first. Third leg. Femur dorsal 1-1-0, elsewhere 0. Patella dorsal 1-1, elsewhere 0. Tibia dorsal 1-1-0, prolateral 1-1, retrolateral 1-1, ventral 0. Metatarsus dorsal 1-1-0,

prolateral 1-1-1, retrolateral 1-1-1, ventral 1-0-2. Fourth leg same as third.

Three claws. Upper claws (Fig. 321) similar, long and slender, bent a little beyond middle, with an almost straight, fine distal end, with a row of about 16 fine and long teeth increasing in length distally. Third claw very slender, smooth, bent at right angles. Trichobothria (Fig. 320) are few and very long. One on the tibiae a little behind middle, one on the metatarsi about a quarter from the distal end, one on tarsi about one third from distal end. The legs are sparsely clothed with simple hair.

Abdomen elongated (Fig. 322), more pointed behind than in front, 1.5 mm. long without spinnerets, 0.88 mm. wide. The anal tubercle is cone-shaped, two jointed, large. Six spinnerets (Fig. 314 and 315), cylindrical. Anterior pair stouter and just a little longer than posterior pair. The former are contiguous, the latter separated by the anal tubercle. The median pair is quite small. A well developed colulus is in front of the anterior spinnerets. On the truncature of the terminal joint of the anterior spinnerets four spigots are situated (Fig. 318). At the end of the posterior spinnerets (Fig. 313) five simple spinning tubes are present. The spinning tubes of the median spinnerets cannot be seen because of some white extraneous matter adhering to them. At any rate it is certain that the total number of spinning tubes in this species is more than double that in *Adjutor mirabilis*.

The genital fold cannot be seen because it is hidden by the third and fourth left femora. The ventral surface of the abdomen behind the genital fold is deeply concave probably having collapsed under pressure of the drying gum when the spider became entangled in it. This concavity is occupied by a large air-bubble.

The right palp is fully exposed permitting a complete drawing with the aid of a camera lucida (Fig. 319) showing the relative proportions of the joints. At the end of the palp is a slender claw (Fig. 316) with six very slender teeth.

### Subfamily *Adjuntorinae*

#### Genus *Adjuntor*, nov.

Carapace low. Anterior portion of head with almost parallel sides. Eyegroup not quite as wide as head. Eight eyes in two

rows, subequal. Quadrangle square. Clypeus low. Maxillae parallel. Palp inserted near base. Sternum convex, oval, widely truncated in front, pointed behind. First coxae wide apart. Fourth coxae separated by more than their width. Spines on legs numerous, long and erect. Trichobothria long and numerous. Third claw reduced to a thorn. Spinnerets cylindrical, anterior pair somewhat stouter than posterior pair. Type *A. similis*.

(Derivation of name: Latin—adjunctor—one who unites.)

*Adjunctor similis*, n. sp. Plate LXIV, Fig. 585. Plate XXXIV, Figs. 323 to 328.

British Museum, collection from Samland, In. 18085.

Type. Immature female. A well preserved specimen in perfectly clear amber which is considerably darker around the spider. Color of chitin dark brown.

Total length without spinnerets 2.2 mm. Carapace (Fig. 323) 1.0 mm. long, 0.84 mm. wide, with sides of thoracic portion strongly curved and with sides of head almost parallel. The width of the head is only half that of the maximum width of the carapace. The width of the posterior row of eyes is 0.38 mm., *i. e.* the eyegroup is by 0.04 mm. narrower than the head. The eyes cannot be measured, but appear to be subequal in size. The first row is slightly recurved and a little shorter than the second row which is almost straight. In a lateral view (Fig. 326) the head is almost level, the posterior declivity steep. The thoracic groove has the shape of a longitudinal depression. There are five pairs of long bristles on the carapace in the median line while shorter bristles are scattered over the surface. The quadrangle is square. The clypeus is low. There are three pairs of bristles in a transverse row on the clypeus.

The chelicerae are black, distinctly converging. On account of their color their structure cannot be determined. The maxillae (Fig. 324) are parallel and the palp is inserted near the base. The lip is free, somewhat wider than long and reaches the middle of the maxillae. The sternum is convex, oval, widely truncated in front, its posterior pointed end evenly rounded. First coxae wide apart. Fourth coxae separated by more than their width. None of the trochanters are notched. The legs appear to be laterigrade, but that is a feature extremely difficult to decide in fossil spiders.

Leg formula	4	1	2	3
	3.0	2.5	2.3	2.3

	Femur	Pat. + Tib.	Metat.	Tarsus	Total
I	0.80	0.84	0.44	0.40	2.48
II	0.64	0.84	0.40	0.40	2.28
III	0.68	0.76	0.48	0.36	2.28
IV	0.80	1.00	0.68	0.48	2.96

Width of first patella 0.144 mm. First tibial index 17.

Width of fourth patella 0.144 mm. Fourth tibial index 14.

Spines long, erect and numerous. First leg. Femur dorsal 1-1-0, prolateral 0-1-0, elsewhere 0. Patella dorsal 1-1 very fine bristles, elsewhere 0. Tibia ventral 2-2-0, the end of the first pair reaching beyond the base of the second. Elsewhere 0. Metatarsus ventral 2-0, elsewhere 0. Second leg same as first. Third leg. Femur dorsal 1-1-0, elsewhere 0. Patella dorsal 1-1 long, fine bristles, elsewhere 0. Tibia dorsal 1-1 fine bristles, ventral 0-1p-2, the single spine slender, the apical pair fine and short. Elsewhere 0. Metatarsus ventral 2-0, elsewhere 0. Fourth leg same as third except: Tibia prolateral 0-1-1. Metatarsus dorsal 1-1, prolateral 1-1, retrolateral 1-1, ventral 2-2.

Three claws, the third claw reduced to a mere thorn (Fig. 327). Upper claws similar, bent, with a row of six long teeth. Claw tufts wanting. What seems to be a very scanty scopula of minutely serrated bristles is present on the metatarsus and tarsus of the first and second pair of legs. There is nothing of the kind on the third and fourth legs. Trichobothria long and numerous. (Fig. 328.) Their distribution is not quite the same on all legs. There are three in a row on all tibiae and those on the third tibia are easily as long as the tibia itself. On the first metatarsus is a row of six trichobothria, on the second a row of five, on the third a row of three. They are longer than the metatarsus itself. On all tarsi there are only two trichobothria and while shorter than the tibial and metatarsal trichobothria they are at least as long as the tarsus itself. The hair on the legs is of a simple kind, curved forward.

The abdomen is ellipsoidal, 1.30 mm. long without spinnerets, 0.88 mm. wide, shiny, very sparsely clothed with fine, curved hair. Six spinnerets, cylindrical, not greatly different in length. The anterior pair are contiguous and somewhat stouter and longer

than the others (Fig. 325). Whether a colulus is present or wanting it is impossible to decide. The ventral wall of the abdomen bulges in front of the genital fold, but no epigynum can be seen.

### Family *Linyphiidae*

The history of the Family *Linyphiidae* is interesting in many respects. In the early days of arachnology its genera were included in the Family *Theridiidae* together with other genera long since removed to other groups. Bertkau recognized the *Linyphiidae* as a separate family and tried also to establish another Family *Micryphantidae* on the basis of differences in the structure of the tracheal system. Simon clearly delimited the *Theridiidae*, included the *Linyphiinae* as First Subfamily in the Family *Argiopidae* and divided the subfamily into three groups, the *Erigoneae*, the *Formicineae* and the *Linyphieae*. Later others, myself included, raised the status of Simon's Subfamily *Linyphiinae* again to the status of a family. Still more recently I have attempted to revive Bertkau's *Linyphiidae* and *Micryphantidae* on the basis of new investigations into their tracheal system. The Family *Linyphiidae* as I delimit it includes only representatives with a tracheal system limited to the abdomen and corresponds to Simon's *Linyphieae* and *Formicineae*, or to the Subfamily *Linyphiinae* of my Systema Araneorum. The eight fossil genera which I refer to the Family *Linyphiidae* here conform with the definition of the family as given in my Catalogue of American Spiders, and to the Subfamily *Linyphiinae*. Each genus is represented by a single species, one of them a female, the other seven mature males. Three of these clearly show the paracymbium so characteristic of the family.

### Key to Genera

1. The edge of the carapace is thickened forming a wall  
AME largest. Eyes on tubercles ..... *Meditrina*.
- \* Edge of carapace not thickened, normal ..... 2
2. Bulb of male palp with a conspicuous spike (embolus?)  
directed forward ..... *Custodela*.
- \* Bulb without conspicuous spike ..... 3
3. Tibia of male palp with a terminal brush of five or six  
very long bristles ..... *Malleator*.
- \* Tibia of male palp without terminal brush of long bristles 4

4. Order of legs 1423. Lip almost pentagonal, twice as wide in middle as at base. Upper claws dissimilar, proclaw smooth, retroclaw with six teeth ..... *Impulsor*.
- \* Order of legs 1243. Lip widest at base. Proclaw with teeth ..... 5
5. Lip much wider than long, distinctly rebordered. Sternum triangular, much longer than wide. Proclaw with two teeth, retroclaw with five teeth. Paracymbium large, in the shape of a widely open screw ..... *Eopopino*.
- \* Lip not much wider than long. Sternum with distinctly convex sides, not much longer than wide. Claws and paracymbium not as above ..... 6
6. Claws slightly dissimilar, proclaw with five, retroclaw with eight teeth. Bulb of male palp with a black, pickaxe shaped apophysis ..... *Obniscus*.
- \* Not so ..... 7
7. All eyes on a common tubercle. Legs and abdomen distinctly setose. Abdomen ovoid, pointed behind ..... *Liticen*.
- \* Eyes on separate eye tubercles. Legs and abdomen not setose. Abdomen wider behind than in front ..... *Mystagogus*.

Genus *Eopopino*, nov.

Carapace almost circular. Eight eyes in two rows. AME considerably smaller than ALE. Quadrangle much wider behind than in front and much wider than long. Lip much wider than long, distinctly rebordered. Sternum triangular, much longer than wide. First coxae wide apart. Fourth coxae separated by the posterior end of the sternum. Order of legs 1243. Spines and bristles wanting. Upper claws slightly dissimilar. Proclaw with two teeth, retroclaw with five teeth. Type *E. longipes*.

(Derivation of name: Latin—popino—a gormandizer.)

*Eopopino longipes*, n. sp. Plate LVIII, Fig. 536. Plate II, Figs. 12 to 15. Sedgwick Museum, University of Cambridge. No. C 6649.

Type. Mature male. A single, well preserved specimen in clear, dark yellow amber. The first and fourth right legs are miss-

ing. the second right leg is incomplete. The color of the chitin is brown. the abdomen somewhat lighter.

Total length 2.32 mm. Carapace 1.04 mm. long, 1.00 mm. wide, flat and almost circular. It is pressed out of shape, so that it is impossible to decide whether a thoracic groove is present. Eight eyes in two rows. Anterior row almost straight. AME about half as large as ALE and the eyes of the anterior row are equidistant. The posterior row is slightly procurved, longer than the anterior row and the PME are farther apart from each other than from the PLE. The quadrangle is much wider behind than in front and much wider than long. The eyes of the posterior row are about of the same size as the ALE. The clypeus is as high as the quadrangle. There is no hair on the carapace.

The chelicerae are rather short, with very oblique margins. Their armature cannot be seen. The fangs are evenly curved. The maxillae (Fig. 12) are slightly inclined over the lip, with rounded outer angle. A thick scopula and a distinct serrula are present. The lip is short, much wider than long, distinctly rebordered. The sternum is triangular, longer than wide, truncated anteriorly, bluntly pointed between the hind coxae. First coxae wide apart. Fourth coxae separated by about their width.

Leg formula	1	2	4	3
	9.8	6.2	6.1	4.4

	Femur	Pat. + Tib.	Metat.	Tarsus	Total
I	3.00	3.33	2.70	1.14	10.17
II	1.98	2.04	1.74	0.66	6.42
III	1.50	1.26	1.14	0.66	4.56
IV	2.28	1.68	1.62	0.72	6.30

The legs are slender, clothed only with simple hair. Spines and bristles wanting. A few somewhat stouter hairs are present on all tibiae. Trichobothria numerous. A row on all tibiae, increasing in length distally. Apparently several trichobothria on the metatarsi, but their arrangement is not easy to ascertain because of the presence of erect hairs. Three claws. Upper claws dissimilar. Proclaw with two teeth, retroclaw with five teeth. Third claw bent at right angles, with a single tooth. Claw-tufts and scopulae wanting. No tarsal comb, but two serrated bristles are present under the claws (Fig. 13).



The abdomen is ovoid, 1.2 mm. long, 1.0 mm. wide. The spinnerets cannot be clearly seen.

The palpi are very characteristic. Compared with the femur (Fig. 14) the cymbium is very large, while the patella and tibia are quite small. The tibia has no apophysis. The paracymbium is very large, flat, directed outward and has the shape of a widely open screw (Fig. 15). The embolus is fine, strongly curved, giving the impression that it is spirally wound, but imperfections of the amber make a decision of this point impossible.

Genus *Malleator*, nov.

Carapace almost circular with two shoulder humps and a low turret bearing the eyes. Both rows of eyes recurved. Lateral eyes contiguous. All four eyes of the first row contiguous, those of the second row equally spaced by more than their radius. Eyes equal. Quadrangle almost square. Clypeus high. Sternum wide in front, pointed behind. Order of legs 4123. Upper claws similar, with a single tooth. Third claw bent at right angles, smooth. Abdomen ovoid. Femur of male palp slightly longer than carapace. Tibia with a terminal brush of five or six very long bristles. Type *M. niger*.

(Derivation of name: Latin—malleator—a hammerer.)

*Malleator niger*, n. sp. Plate LX, Fig. 554. Plate IX, Figs. 83 to 85.

British Museum, collection from Samland, In. 18944.

Type. Mature male. A single specimen in dark yellow amber containing some air bubbles. Color of chitin black.

Total length 2.36 mm. Carapace (Fig. 85) practically circular, 1.0 mm. wide between second coxae, with a pair of shoulder humps, a deep longitudinal thoracic groove between the humps and a peculiar, somewhat mushroom shaped turret bearing the eyegroup. Head considerably lower than thorax (Fig. 84). Posterior declivity steeply curved. Eight eyes in two rows, protruding beyond the edge of the eye turret. Width of eyegroup 0.43 mm. Both rows strongly recurved. All eyes equal. Quadrangle almost square, only very little longer than wide. Lateral eyes contiguous. Eyes of first row contiguous. Eyes of second row separated by about two-thirds of their diameter. The clypeus is high, but cannot be measured on account of the position of the spider.

The view of the chelicerae, lip and maxillae is obstructed by air-bubbles and the palpi. The sternum is partly visible. It is very wide in front, more or less pointed behind. First coxae wide apart. Fourth coxae very close together, barely separated. Legs rather long.

Leg formula	4	1	2	3
	6.2	6.1	4.0	3.1

	Femur	Pat. + Tib.	Metat.	Tarsus	Total
I	1.88	1.40	2.08	0.72	6.08
II	1.28	1.28	0.92	0.52	4.00
III	1.00	0.84	0.80	0.50	3.14
IV	1.80	1.92	1.72	0.72	6.16

Legs clothed with stout hair, especially stout on the tarsi. Spines wanting, but bristles present. Their disposition is difficult to ascertain, because they are not much stouter than the hair. A long bristle may be seen at the end of the patella and one before the middle on the tibia. A row of four or five trichobothria is present on the tibia. Claw-tufts wanting. Three claws. Upper claws similar, bent, with a single tooth. Third claw bent at right angles, smooth. Abdomen ovoid, high, sparsely clothed with bristles. It is of the Theridiid type, higher than long, 1.2 mm. long, 1.04 mm. wide, 1.7 mm. high.

The palp is characterized by the rather unusual length of the femur which is 1.12 mm., *i. e.* longer than the carapace. The tibia is elongated, not quite half as long as the femur and has at its end a brush of five or six very long bristles, almost as long as the femur. Tibial apophysis and paracymbium wanting (Fig. 83). The structure of the bulb cannot be seen, but its general shape suggests that it is longer than wide.

The absence of a paracymbium makes the familial affiliation uncertain, especially when one remembers that the mouthparts cannot be seen. The tarsal comb being wanting it is certain that the species is not a Theridiid.

#### Genus *Custodela*, nov.

Carapace fairly low, with a longitudinal groove and a very gradual posterior declivity. Head higher than thorax. Eight eyes on four tubercles. Eyes of first row somewhat smaller than eyes of second row. Quadrangle slightly wider behind and about

as long as wide. Clypeus high. Chelicerae slender, with oblique margins and short fangs. First coxae wide apart. Fourth coxae very little separated. Order of legs 1243. Legs with slender spines. Three claws. Upper claws similar, with a series of minute teeth. Third claw bent at right angles, smooth. Spurious claws wanting. Male palp with a hook-shaped paracymbium and a powerful spike, possibly the embolus, directed forward. Type *C. cheiracantha* (Koch and Berendt).

(Derivation of name: Latin—custodela—a guard.)

*Custodela cheiracantha* (Koch and Berendt) Plate LX, Fig. 556. Plate XIV, Figs. 129 to 135.

*Linyphia cheiracantha* Koch and Berendt, 1854, p. 41, Plate XVI, Fig. 137.

? *Linyphia oblonga* Koch and Berendt, 1854, p. 40, Plate IV, Fig. 30.

The synonymy is that of Menge who states on p. 42 that he has examined Berendt's original specimens, compared them with six specimens of his own collection and does not doubt that *oblonga* and *cheiracantha* belong to the same species. Modern rules of nomenclature not having been in vogue at the time, Menge selected the name *cheiracantha* for the species. Koch's figures look different. The spider described below is undoubtedly Koch's *L. cheiracantha*. A new genus had to be erected for it.

Hypotype. Male. British Museum, In. 18765. Klebs 523, No. 13+25. A well preserved specimen in clear amber. Ventral surface covered with white emulsion. Color of chitin brown, abdomen light buff.

Total length 3.8 mm. Carapace (Fig. 129) 1.32 mm. long, 1.12 mm. wide between second and third coxae where it is widest, evenly rounded anteriorly where it is only a little wider than the eyegroup. Thoracic groove deep, longitudinal. Head clearly set off from the thoracic portion, the cephalothoracic sulci reaching the midline on the carapace considerably in advance of the thoracic groove. Viewed from the side (Fig. 133) the carapace appears to be fairly low, sloping gradually backward from the posterior end of the head and rising forward almost to the posterior end of the eyegroup. From here on forward the head curves down rapidly. The eight eyes are placed on four tubercles each bearing a pair of eyes. Disregarding the tubercles one may say that the

eyes are arranged in two rows, the anterior row strongly recurved, the posterior row slightly procurved and a little longer. Ratio of eyes AME:ALE:PME:PLE = 6:6:7:7. AME contiguous, but distinctly separated from the lateral eyes. PME also contiguous but separated by at least their diameter from the PLE. The lateral eyes are contiguous. The quadrangle is slightly wider behind than in front and about as long as wide. The clypeus is concave and as high as the quadrangle. There is a crest of small bristles on the head in the mid-dorsal line, but very little pubescence on the rest of the carapace.

The chelicerae are long and slender, with oblique, but short margins (Fig. 130). The promargin is smooth, with three fine bristles. The retromargin is not visible. A boss is wanting. The fang is short and evenly curved. Maxillae and lip concealed by white emulsion. The sternum is also not visible, but one can see plainly that the first coxae are wide apart, while the fourth coxae are only very slightly separated. The legs are long and slender (much longer than in Koch's figure of this species and more like his figure of *Linyphia oblonga*).

Leg formula	1	2	4	3
	7.2	6.0	5.2	4.5

	Femur	Pat. + Tib.	Metat.	Tarsus	Total
I	2.48	2.88	2.68	1.40	9.44
II	2.20	2.40	2.28	1.08	7.96
III	1.68	1.80	1.68	0.72	5.88
IV	1.92	2.20	2.00	0.80	6.92

Width of first patella 0.195. First tibial index 6.8.

Width of fourth patella 0.168. Fourth tibial index 7.6.

Legs clothed with short, stiff hair. Spines long and few. First leg. Femur dorsal 1 before middle, prolateral 1 beyond middle, elsewhere 0. Patella dorsal 1-1, the first a bristle, the second a spine, elsewhere 0. Tibia dorsal 1-0-1, prolateral 0-1-1, retrolateral 0-1-1, ventral 0-1r-2. Metatarsus 0. Second leg same as first. Third leg. Femur dorsal 1 before middle, elsewhere 0. Patella dorsal 1-1, the first a bristle, the second a spine, elsewhere 0. Tibia dorsal 0-1-0, prolateral 0-0-1, retrolateral 0-0-1, ventral 0-0-2. Metatarsus 0. Fourth leg same as third.

Three claws (Fig. 132). Upper claws similar, bent, with a row

of minute teeth which can be seen only under high power and then only in a certain light. Under low power the claws appear smooth. Third claw bent at right angles, smooth. Claw-tufts, spurious claws and scopulae wanting. Whether the curved bristles under the claws are minutely serrated or not, it is not possible to decide. A row of four trichobothria is present on the tibiae and one trichobothrium is visible on the first tarsus.

The abdomen is an elongated oval, 1.7 mm. long, 1.0 mm. wide, sparsely clothed with fairly long, brown bristles. The spinnerets are coated with white emulsion, but the group has the shape of a rosette and the anal tubercle is large.

The male palp is the most characteristic feature of the species. The femur is slender, the tibia is scarcely longer than the patella, the terminal joint is very large (Figs. 134 and 135). A sickle-shaped dorsal paracymbium is present and the bulb has an almost straight, long, pointed spike directed forward when the palp is lowered as happens in the specimen under consideration. It may be that this spike is the embolus, but no duct can be seen. Examination in sideview suggests that the spike is a conductor with a very slender embolus applied to its full length.

#### Genus *Meditrina*, nov.

Carapace with greatly thickened edges and a pair of shoulder humps. Eight eyes in two rows, gently recurved. ALE slightly larger than the other eyes. Lateral eyes contiguous. First coxae very wide apart. Order of legs 1243. Legs setose with very slender and few spines. Upper claws of first and second leg curved, with a row of fine teeth. Upper claws of third and fourth leg bent and smooth. Type *M. circumvallata*.

(Derivation of name: Latin—*meditrina*—the goddess of healing.)

*Meditrina circumvallata* n. sp. Plate LXIII, Fig. 574. Plate XXXVII, Figs. 354 to 359.

British Museum, collection from Samland, In. 18159.

A single specimen, originally in a large piece of amber with a number of insects, from which the portion containing the spider

was cut off and polished. The entire ventral surface is heavily coated with white emulsion. The color of the chitin greyish rufous.

Type. Female. Total length 2.9 mm. Carapace 1.2 mm. long, 1.04 mm. wide between second and third coxae. It is narrowed anteriorly to the width of the eyegroup which is 0.53 mm. The head is clearly and more or less sharply set off from the thoracic portion. The thoracic groove has the shape of a transverse depression with a recurved anterior edge. On each side of the depression is a shoulder hump forming the highest region of the carapace. The cephalothoracic sulci are fairly deep. The posterior declivity is steep. The unusual and most characteristic feature of the carapace is presented by its lateral and posterior margins (Fig. 356) which are considerably thickened and rounded forming a regular wall the shape of which is best understood from the diagrammatic figure 355 showing the margins as they would appear in a transverse section. Personally I cannot recollect any recent or fossil spider with a similar thickening of its margins. There are a few bristles in the median line on the carapace, but its surface is otherwise glabrous and shiny.

Eight eyes in two rows. Because the anterior femora obstruct the view of the head a strictly dorsal view is impossible. In a position as near dorsal as practicable the first row of eyes appears to be considerably below the second row and is recurved. The second row which is slightly longer, is also less recurved. The quadrangle is wider behind than in front in ratio 12:9 and wider than long in ratio 12:10. The AME are on a common tubercle. The lateral eyes are also on a common tubercle and between these tubercles is a deep depression. Ratio of eyes AME:ALE:PME:PLE = 3:4:3:3. The PME are separated from each other by their diameter. The lateral eyes are contiguous. The clypeus is not visible on account of emulsion.

Of the chelicerae the outer edge of the left chelicera and the base of the fang are visible. The basal joint is about 0.64 mm. long. Of the maxillae only the outer and anterior edge of the left maxilla are visible. The anterior edge protrudes beyond the chelicera. Lip, sternum and coxae cannot be seen, but the latter are partly visible through the emulsion so that it is possible to state definitely that the sternum is quite wide in front because the first coxae are very wide apart.

Leg formula	1	2	4	3
	5.0	3.7	3.0	2.0

	Femur	Pat. + Tib.	Metat.	Tarsus	Total
I	1.80	2.00	1.48	0.76	6.04
II	1.36	1.36	1.08	0.60	4.40
III	0.80	0.76	0.48	0.40	2.44
IV	1.20	1.12	0.80	0.44	3.56

Width of first patella 0.192. First tibial index 9.6.

Width of fourth patella 0.144. Fourth tibial index 12.8.

First and second femora much stouter than third and fourth. First metatarsus distinctly curved downward.

Spines few and more like bristles than like true spines. They are clearly visible only because they stand at a different angle from the hair from which otherwise the spines would be difficult to separate and which gives the legs a distinctly setose appearance.

Spines. First leg. Femur dorsal 1-1-1, prolateral 0-0-1, elsewhere 0. Patella dorsal 1-1, elsewhere 0. Tibia dorsal 1-1-0, prolateral 0-1-1, retrolateral 0-0-1, ventral 0. Metatarsus dorsal 1-0, elsewhere 0. Second leg same as first. Third leg. Femur 0. Patella dorsal 1-1, elsewhere 0. Tibia dorsal 1-1, elsewhere 0. Metatarsus dorsal 1-0, elsewhere 0. Fourth leg same as third except metatarsus 0.

Three claws. Upper claws while similar on each leg are of a different structure on the anterior and posterior legs. On the first and second leg (Fig. 357) both upper claws have a series of fine, short teeth. Their exact number is difficult to determine, but apparently there are at least a dozen teeth, and the claws themselves are gently curved. On the third and fourth leg the upper claws are bent one third from base and again near the tip, and apparently are smooth. Serrated bristles are present under the claws. The third claw has a minute tooth. The palpal claw (Fig. 358) is slender and has a few small teeth. Claw-tufts and scopulae as well as a tarsal comb are wanting. The trichobothria are difficult to see because they are rather short. One can see on the first tibia three trichobothria which are about as long as the spines. Besides the setose hair on the legs, mentioned above, one sees both in the dorsal and ventral midline of the metatarsi much shorter, erect hair.

The palpi are also clothed with setose hair and some distinct

bristles are present. The terminal joint is quite long and provided with a claw. There is one lone trichobothrium on the tibia of the palp.

The abdomen, displaced to one side, is ellipsoidal (Fig. 359) 2.0 mm. long, 1.4 mm. wide and overhangs the carapace. It is sparsely clothed with short hair. Only the left portion of the spinning group is visible. The genital fold is deep, transverse, straight. No epigynum can be seen.

#### Genus *Obnisus*, nov.

Carapace strongly narrowed in front, with head considerably elevated. Lip rebordered, wider than long. Maxillae convex on underside and very wide in front. Sternum convex, wide in front, pointed behind. First coxae wide apart. Second and third coxae considerably separated on each side of the carapace. Spines on legs few and slender. Three claws. Upper claws dissimilar. Third claw long, with a single long tooth. Six spinnerets forming a rosette. Colulus present. Bulb of male palp with a pickaxe shaped apophysis. Type *O. tenuipes*.

(Derivation of name: Latin—obnisus—trouble.)

*Obnisus tenuipes* n. sp. Plate LXV, Fig. 592. Plate XXIX, Figs. 273 to 278. British Museum, collection from Samland, In. 18116.

Type. Mature male. A single specimen originally in a fairly large piece of amber so polished that most legs were cut across the metatarsus, only the second and third right legs complete. The amber was not only considerably darkened around the specimen, but presented many planes of cleavage with pockets of air obstructing visibility. To make a thorough study of the specimen possible the excess amber was cut away until the specimen became visible from all sides. It is a badly distorted specimen requiring patient study from various angles of view. The color of the chitin is brown, abdomen slightly lighter, palpi almost black.

Total length 2.2 mm. Carapace 0.96 mm. long, 0.80 mm. wide between second and third coxae where it is widest. It is strongly narrowed in front where measurement is unfortunately impossible because of distortion. Thoracic groove not visible. The head is considerably elevated above the thorax (Fig. 273) and separated



from it by clearly visible sulci. The posterior declivity is steep. The surface is glabrous, apparently without any hair. The femora obstruct the view of the eyegroup which can be seen only very imperfectly.

Neither the chelicerae, nor the mouthparts are clearly visible, but enough can be seen to warrant the statement that the chelicerae are short and slender, distinctly excavated on the inside, and the lip wider than long and strongly rebordered. The maxillae are much wider in front than at the base and their lower surface is convex. The sternum is distinctly convex, very wide in front, pointed behind. The first coxae are wide apart. The fourth coxae are separated by about their width. Measurements of the sternum are not possible, but the impression is that the sternum is almost circular with a pointed posterior end. Between second and third coxae on each side there is a distinct space. The legs are thin and fairly long.

	Femur	Pat. + Tib.	Metat.	Tarsus	Total
I	1.80	2.00	...	...	?
II	1.40	1.60	1.40	0.72	5.12
III	1.05	1.20	0.84	0.52	3.61
IV	1.32	1.28	...	...	?

Width of first patella 0.096. First tibial index 4.8.

Spines are few, long and slender like bristles (Fig. 276). Their distribution seems to be the same on all legs. There is 1 dorsal apical spine on the patella, 1-1 dorsal spines and a distal pair of ventral spines on the tibia and 1 dorsal spine on the metatarsus one-third from base. No other spines.

Three claws (Fig. 275). Upper claws slightly dissimilar. Pro-claw more strongly bent and with a row of six fine teeth increasing in length distally. Retroclaw less bent, with shorter teeth, eight in number. Third claw long, stout at base and bent at right angles with very slender distal half and a long, fine, single tooth. Neither serrated bristles, nor spurious claws can be seen. Claw-tufts, scopulae and tarsal comb wanting. Trichobothria few. There are none on the femora, one on the tibiae close before the distal spine and one on the metatarsi halfway between the base and the spine. None on the tarsi. The legs are sparsely clothed with only simple hair.

The abdomen is more or less cylindrical (Fig. 273) 1.25 mm.

long, 0.60 mm. wide, with several transverse groove-like depressions in the posterior region possibly representing segmentation. Six spinnerets (Figs. 276 and 277) form with the anal tubercle a neat circle. Anterior pair separated at their base by a distinct colulus. Posterior pair separated by the anal tubercle. Median pair very small. The anterior and posterior spinnerets are cone-shaped and about equally long and stout. The genital fold is distinctly visible and is very strongly procurved. The surface of the abdomen is so shiny that no hair can be seen at the first glance. Careful examination under high power reveals, however, that the abdomen is sparsely clothed with short hair, each hair separated from the others by about its length.

Both palps are well preserved, but so flexed that nothing but their terminal joint is visible (Fig. 274). Owing to this position it is impossible to say whether a paracymbium is present. The bulb itself is large and is characterized by the presence of an almost black, pickaxe shaped apophysis. The femur can be partially seen in a side view and appears to be quite slender by comparison with the terminal joint.

Genus *Liticen*, nov.

Carapace with rounded sides, not much narrowed in front. Head considerably wider than eyegroup. The eyes forming the quadrangle distinctly smaller than the lateral eyes. Quadrangle square. Lateral eyes contiguous. Anterior row of eyes recurved, posterior row straight. The entire eyegroup on a common tubercle. Clypeus high. Sternum triangular, very wide in front. First coxae wide apart. Order of legs 1243. Legs slender, distinctly setose, without spines. Three claws. Upper claws similar, bent, with a row of four teeth. Abdomen ovoid, with bristles. Male palp with spiral embolus. Paracymbium pentagonal. Type *L. setosus*.

(Derivation of name: Latin—liticen—a trumpeter.)

*Liticen setosus*, n. sp. Plate LXVII, Fig. 603. Plate XXXIV, Figs. 329 to 332. Plate XLV, Figs. 427, 428.

British Museum, collection from Samland, In. 18118.

A single, well preserved specimen in a rather poor piece of amber of peculiar shape and dark color around the spider. The first left leg polished off across the femur by the previous owner, but in such

a manner that the metatarsus and tarsus remained intact. The color of the chitin of the carapace brown, legs rufous, abdomen somewhat lighter. Palpi black. A few tiny spots of white emulsion on the sternum.

Type. Mature male. Total length 2.4 mm. Carapace overhung by the abdomen, but the latter is so transparent that the posterior edge of the carapace is plainly visible through the abdomen. The carapace is 1.2 mm. long, 1.2 mm. wide between second and third coxae. The sides of the carapace (Fig. 332) are convex. The width of the head is considerably greater than the width of the eyegroup. The face is 0.4 mm. wide. No thoracic groove can be seen. The head is clearly set off from the thoracic portion. The eyegroup is on a common tubercle. There is a crest of long, curved bristles directed forward in the mid-dorsal line of the head.

The eyegroup can be seen only with difficulty by using very strong light at a certain angle. The eyes form two rows. The anterior row is recurved. The posterior row is straight. Ratio of eyes  $AME:ALE:PME:PLE=3:4:3:4$ . The quadrangle is square. The lateral eyes are contiguous. The AME are separated from each other by not quite two diameters ( $5/3$ ) and from the ALE by  $4/3$  of their diameter. The PME are separated from the PLE by their diameter. The clypeus is somewhat slanting, high.

The view of the chelicerae is almost completely obstructed by the palpi. Examined from below they appear to be short, with parallel outside edges and oblique margins. The maxillae (Fig. 331) are more or less parallel and reach the end of the basal joint of the chelicerae. The lip is free, almost triangular, but with rounded end. The sternum is slightly convex, longer than wide, its anterior angles rounded, its posterior end pointed between the hind coxae. First coxae wide apart. Fourth coxae separated by about their width.

Leg formula	1	2	4	3
	6.1	5.0	4.3	3.3

	Femur	Pat. + Tib.	Metat.	Tarsus	Total
I	2.00	2.50	1.92	0.84	7.26
II	1.80	2.00	1.48	0.76	6.04
III	1.28	1.20	0.92	0.60	4.00
IV	1.60	1.60	1.28	0.64	5.12

First and second femora distinctly stouter than the others. The legs are distinctly setose (Fig. 428). All setae are long and stiff, pointed. They are quite conspicuous on the ventral surface of the femur of the first leg. True spines are wanting, but there are the usual dorsal bristles, one on the patella and one on the tibia close to the proximal end. These bristles are scarcely longer than the setae, but stand at a different angle. A prolateral and a retro-lateral row of short, erect hairs is present on the tarsi and metatarsi. Trichobothria are numerous. There are two rows of them on the tibia and several trichobothria may be seen on the metatarsi and tarsi, but their arrangement is not clear. There certainly are none on the femora.

Three claws (Fig. 330). Upper claws presumably similar, bent, with a row of four teeth increasing in length distally. Third claw long, strongly bent, smooth.

The abdomen (Fig. 427) is ovoid, pointed behind, 1.5 mm. long, 1.3 mm. wide, very sparsely clothed with long, curved brown bristles. Some of these bristles are fully 0.6 mm. long when measured in a straight line from base to tip. Six spinnerets plainly visible in side view. They are arranged in a rosette. The anterior pair is slightly longer and stouter than the posterior pair which otherwise closely resembles them. The median pair is small. The anal tubercle is long. Whether a colulus is present cannot be decided. The ventral surface of the abdomen is also clothed with bristles which, however, are neither as long, nor as stout as those on the back.

The palpi are characterized by the comparatively large size of the terminal joint (Fig. 329). The paracymbium is pentagonal. The embolus is long, slender and forms two turns of a spiral.

#### Genus *Mystagogus*, nov.

Carapace gradually narrowed anteriorly to the width of the eye-group. Lateral eyes contiguous. Eyes subequal. Quadrangle slightly wider behind than in front and slightly wider than long. Thoracic groove longitudinal. Lip triangular. Maxillae inclined over lip. Sternum oval, truncated in front. First coxae wide apart. Order of legs 1243. True spines wanting. Tarsal comb, claw-tufts and scopulae wanting. Three claws. Upper claws smooth. Abdomen wider behind than in front. Palp of male with a tibial apophysis. Type *M. glabrus*.

(Derivation of name: Latin—mystagogus—a mystagogue.)

*Mystagogus glaber*, n. sp. Plate LXV, Fig. 593. Plate XXXVI, Figs. 347 to 350. Plate XLVII, Fig. 446.

British Museum, collection from Samland, In. 18125.

A poorly preserved specimen in a piece of dark amber with many planes of cleavage, but free of white emulsion. Color of chitin brown with golden reflections.

Type. Mature male. Total length 2.2 mm. Carapace 1.00 mm. long, 0.84 mm. wide between second and third coxae where it is widest. Anteriorly the carapace becomes gradually only as wide as the eyegroup, *i. e.* 0.34 mm. The thoracic groove is longitudinal, deep and very long. The head is clearly set off from the thoracic portion by sulci. The posterior declivity is quite gentle. The AME are on a common tubercle projecting beyond the clypeus. The eight eyes are subequal. The quadrangle is wider behind than in front in ratio 8:7.5, wider than long in ratio 8:7. The AME are separated from each other by about their diameter. The PME are slightly wider apart. The clypeus cannot be seen. There is no pubescence on the carapace.

The chelicerae cannot be seen clearly. The lip (Fig. 350) is triangular, free. The maxillae are distinctly inclined over the lip. The sternum is ovoid, widest between second coxae, truncated in front to a little more than the width of the lip, pointed behind, longer than wide. First coxae wide apart, second coxae still more so, fourth coxae separated by about their width. Legs long and slender.

Leg formula	1	2	4	3
	6.3	4.6	4.4	2.2

	Femur	Pat. + Tib.	Metat.	Tarsus	Total
I	1.80	1.92	1.68	0.88	6.28
II	1.32	1.40	1.20	0.64	4.56
III	0.68	0.64	0.60	0.32	2.24
IV	1.64	1.20	1.01	0.53	4.38

The fourth femur is slightly curved. True spines are wanting, but the usual dorsal bristles are present, one on the patella, 1-1 on the tibia. A tarsal comb is wanting. At first sight it looks as if a comb were present, but the row of bristles simulating a comb are not serrated and moreover are retrolateral and not ventral, nor are they in any way different from other bristles. Trichobothria cannot be seen. Claw-tufts and scopolae wanting. Three claws (Fig.

345). Upper claws similar, smooth. Third claw long, smooth, stout at base, fine toward end.

The abdomen (Fig. 347) is rounded at posterior end and wider behind than in front. It is 1.3 mm. long, 1.0 mm. wide, about as high as wide, shiny, sparsely clothed with fine, long hair. Six spinnerets (Fig. 348) arranged in a rosette. Anterior pair cone-shaped, contiguous at base, somewhat smaller than posterior pair which is separated by the anal tubercle. The median pair is small. A colulus is wanting. The spinning group is set inside of a circular groove.

The palpi are very difficult to see. The tibia (Fig. 349) has a pointed apophysis. The cymbium is large and completely hides the copulatory apparatus.

Genus *Impulsor*, nov.

Lip deeply excavated in proximal third, so that its base is much narrower than its middle, rounded in front, as long as wide in its widest region. Maxillae strongly inclined over lip. Sternum triangular with angular sides, very wide in front. First coxae wide apart. Legs setose, without spines, but with usual dorsal bristles on patella and tibia. Order of legs 1423. Three claws. Upper claws dissimilar. Proclaw smooth. Retroclaw with a row of six teeth. Third claw bent at right angles, with two teeth. Serrated bristles present. Abdomen ellipsoidal with lateral, longitudinal plications. Tibia of male palp with an external apophysis (retrolateral). Embolus slender, S-shaped. Type *I. neglectus*.

(Derivation of name: Latin—impulsor—an inciter.)

*Impulsor neglectus* n. sp. Plate LXVII, Fig. 605. Plate XLV, Figs. 422 to 426.

British Museum, collection from Samland, In. 18122.

A fairly well preserved specimen in a piece of rather dark amber full of air-bubbles. The entire dorsal surface of the carapace and abdomen have been polished off by the previous owner. Measurements are impossible and the disposition and number of eyes remain unknown. Pieces of legs have been also polished off. However, three legs are complete and of the first leg only the patella and tibia are missing, so that the relative length of all legs can be given and measurements can be made of individual joints. Of the two

otherwise well preserved palpi the dorsal surface of the cymbium has been also polished off, but the copulatory apparatus is complete and the species can therefore be recognized.

Type. Mature male. Total length 2.1 mm. Carapace 0.96 mm. long, 0.79 mm. wide between second and third coxae where it is widest. Although its dorsal portion is missing as explained above, its margin is left and the outline of the latter suggests that the carapace was but little narrowed in front.

The chelicerae are visible in a three-quarter side view. They are rather slender. The basal joint is 0.26 mm. long. The lip (Fig. 422) has a very peculiar shape. Its widest place is approximately in the middle. It is rounded in front and so deeply excavated at the sides in its proximal portion that the base is half as wide as the middle. The lateral angles of the lip are hinged to the anterior projections of the sternum. The maxillae are strongly inclined over the lip, but do not meet in the middle line. The palp is inserted near the base. The sternum is triangular with angular sides due to distinct excavations for the reception of the coxae. In its widest place which is between the first and second coxae the sternum is as wide as long. The anterior truncature has a median excavation for the reception of the lip. The first coxae are very wide apart and are distinctly stouter than the other three pairs. The fourth coxae are separated by about their width. None of the trochanters are notched. In the position of the spider in the amber the complete three right legs are parallel and at right angles to the axis of the body giving the impression that the spider is laterigrade. If that is the natural condition, the Genus *Impulsor* would have to be placed either in the Family *Pisauridae* with which it has little in common, or in a new Family *Impulsoridae* which it would be difficult to define for lack of information concerning the carapace, eyegroup and spinnerets. Moreover, there is no evidence that the legs are really laterigrade, except for their position and the comparatively considerable length of the third pair. The articulations of the individual joints seem to be of the type characteristic of prograde and not of laterigrade spiders.

Leg formula	<sup>1</sup>	<sup>4</sup>	<sup>2</sup>	<sup>2</sup>
	4.9	3.7	3.6	2.3

An explanation of the measurements of the first leg is in place here. The right first leg is completely missing. The left femur

is cut somewhere across its middle so that only its proximal portion is present. The figure given for the length of the first femur is the mean of the sum of the second and fourth femora. The figure given for the first patella plus tibia has been arrived at as follows. The tibia is complete and measures 1.20 mm. The patella of the fourth leg is presumed to have the same length as the first patella, a condition usually found in spiders. The remnant of the first patella present in the specimen makes this presumption plausible. The length of the fourth patella is 0.36 mm. The sum of the two figures gives us the required length as nearly correct as possible.

	Femur	Pat. + Tib.	Metat.	Tarsus	Total
I	1.14	1.56	1.48	0.52	4.70
II	1.08	1.03	0.88	0.43	3.42
III	0.84	0.60	0.44	0.36	2.24
IV	1.15	1.15	0.84	0.41	3.55

The legs are setose. True spines are wanting, but the usual dorsal bristles are present and have almost the appearance of spines, 1-1 on the patella and 1 on the tibia near base. This bristle is quite long and erect. On the first tibia there is also a distal dorsal bristle. Trichobothria are short and very difficult to see. They are easily confused with some of the finer hairs, so that one has to depend entirely on their erect position. Only one trichobothrium on the third tibia about two-fifths from base may be safely recognized.

Three claws (Figs. 425 and 426). Upper claws dissimilar. Proclaw bent, smooth. Retroclaw also bent, but provided with a row of six teeth increasing in length distally. Third claw bent at right angles, with two teeth. At least two stout spurious claws can be seen under the claws. They are fully as stout as and considerably longer than the claws. Claw-tufts and scopulae as well as a tarsal comb wanting.

Abdomen ellipsoidal, 1.10 mm. long, 0.85 mm. wide, clothed on the underside very sparsely with quite short hair. On each side of the abdomen longitudinal plications are visible. It seems probable that these plications extended over the dorsal surface of the abdomen, but unfortunately the latter, as stated above, has been polished off. The spinnerets are present, but on account of a black deposit can hardly be seen. They are quite short, barely projecting beyond the outline of the abdominal wall. The genital fold is clearly visible, as well as the openings of the book-lungs.



The palpi (Figs. 423 and 424) are well preserved and since only the dorsal surface of the cymbium is polished off their structure is clearly visible. The tibia has a retrolateral pointed apophysis. The bulb is very large and ends in a cone-shaped, stout conductor. The embolus is S-shaped, fine, arising from the middle of the bulb as shown in the figure.

#### Family *Argiopidae*

This family comprising all non-cribellated orb-weaving spiders is now usually divided into eight subfamilies. Only two subfamilies seem to be represented in the amber. These are the *Araneinae* and the *Metinae*. Koch and Berendt placed five species in this family which they called *Epeiridae*. Their *Gea epeiroidea* accepted also by Menge as belonging to this genus most probably belongs to some other genus. I have not seen specimens of this species, but the Genus *Gea* as now defined falls into the Subfamily *Argiopinae* characterized by the difference in the size of the lateral eyes, the anterior lateral eyes being much smaller than the posterior lateral eyes. In the description of his species *G. epeiroidea* Koch does not mention the relative size of the lateral eyes, but on the preceding page in the diagnosis of the Genus *Gea* as he understood it at the time he states that the lateral eyes are equal "die Seitenaugen ziemlich dicht genahert, schief stehend, gleich gross, nicht grosser als die zwei hintern Mittelaugen; das vordere ziemlich nahe an den vordern Mittelaugen" (p. 22). Koch's Fig. 12 also shows equal lateral eyes. Koch's *Gea obscura* is according to Menge not a *Gea*. According to Menge it belongs to his Genus *Antopia* which he lists immediately following *Linyphia cheiracantha* among the Family *Theridiidae*. I have shown above that this spider belongs actually into the Subfamily *Linyphiinae* of the Family *Linyphiidae*, although a new Genus *Custodela* had to be erected for it.

Koch's *Zilla porrecta*, *Z. gracilis* and *Z. veterana* are accepted by Menge as good species correctly placed. Menge adds to them two other amber species, *Z. spinipalpa* and *Z. cornumana*. He gives neither figures, nor descriptions of these species. Under the rules of nomenclature they are therefore nomina nuda. Although the list given by Menge on pages 7 and 8 does not include the Genus *Siga*, Menge states on page 27 that he has many specimens of *Siga crinita* in his collection and adds that the Genus *Siga* is closely related to *Zilla*. *Siga crinita* is also a nomen nudum, there

being neither figure nor description of the species. Menge lists also an *Epeira eocena*, *Onca pumila*, *Onca lepida* and *Epeiridion femoratum* under the Family Epeiridae. The status of these species is also that of nomina nuda.

Subfamily *Araneinae* (= *Epeirinae*)

The recent genera belonging to this subfamily are difficult to separate. In my Systema Aranearum no less than 100 genera of recent *Araneinae* are listed. Thorell, Simon, Keyserling, F. O. P. Cambridge and others have tried to define the genera more clearly and more exactly. I have followed Cambridge in my Catalogue. Yet the result is still far from satisfactory. Among fossil spiders which clearly belong to the Subfamily *Araneinae* are several species described by Scudder and by me from the Tertiary of Florissant under the Genera *Epeira* and *Tethneus*. The eight species referred to *Epeira* clearly belong to *Araneus* in Simon's definition, or to any one of the 18 genera recognized by F. O. P. Cambridge in place of Simon's single genus. The Genus *Tethneus* was established by Scudder for four fossil spiders, *T. guyoti*, *T. obduratus*, *T. hentsii* and *T. protractus*, to which I have added *T. twenhofeli* and *T. robustus*, all from the Tertiary of Florissant. Scudder's definition of the genus is quite inadequate from the point of view of modern arachnology. Nevertheless, it has one character common to all species placed under that genus, namely the unusually stout first and second femora. That character is lacking in the Baltic amber *Araneinae*. The two species described below belong to the same new Genus *Eustaloides* closely related to, but distinct from the recent Genus *Eustala*.

Genus *Eustaloides*, nov.

Carapace with shoulder humps representing its highest region, steep posterior declivity, longitudinal thoracic groove and clearly delimited head. Anteriorly the carapace is gradually and considerably narrowed. Lateral eyes contiguous on a common tubercle. AME largest. Sternum triangular with lateral excavations for the coxae, longer than wide, pointed between the hind coxae. First coxae wide apart. No spurs or tubercles on any coxa. Legs spinose, with spines standing at considerable angles to the longitudinal axis of the appendage. Three claws. Upper claws bent, similar or slightly dissimilar. Spurious claws present. Cymbium of male palp with a basal apophysis. Type *E. setosus*.

*Eustaloides setosus* n. sp. Plate LXV, Fig. 590. Plate XXX, Figs. 279 to 288.

British Museum, collection from Samland, In. 18117.

A well preserved specimen in clear but dark amber. The original owner polished off the dorsal surface of the cymbia and most of the first and second right leg. There is a great deal of white emulsion on the sternum and on the mouthparts and a little on the right side of the anterior third of the ventral surface of the abdomen, but the spinnerets are clear of it. What is rather unusual is the fact that the right lung and its opening are clearly visible. The genital opening is also visible. The color of the chitin is very dark brown with greyish predominant on the abdomen.

Type. Mature male. Total length 4.75 mm. Carapace 2.2 mm. long, 1.8 mm. wide between second and third coxae where it is widest, strongly narrowed anteriorly where the eyegroup appears to be wider than the head (Fig. 279). The thoracic groove deep, longitudinal, with a shoulder hump at each side of it. This is the highest region of the carapace (Fig. 280). From here on it slopes gently down anteriorly, while the posterior declivity is steep. The head is clearly separated from the thorax by shallow sulci. The eyes are very prominent. The anterior median pair are elevated on a common tubercle and the lateral eyes are also on common tubercles. Only the posterior median eyes are sessile. The total width of the eyegroup (Fig. 281) is 0.77 mm. Ratio of eyes AME:ALE:PME:PLE = 9:6:6:6. The measurement is not easy. In certain positions of the spider one gets the impression that the PME are much smaller than the lateral eyes, which look almost as large as the AME. This illusion is due to the fact that in such positions one sees really not the eyes, but the tubercle. When the AME and PME are in a horizontal plane the quadrangle appears longer than wide in ratio 17:15 and as wide in front as behind. The anterior row of eyes is strongly recurved, the posterior row so slightly procurved that it may be said to be straight. The PME are distinctly farther apart from each other than from the lateral eyes. The lateral eyes are contiguous. There is a stout bristle on each side of the eyegroup behind the lateral tubercle and one between the PME and PLE. Viewed from in front (Fig. 285) the eyegroup is a little narrower than the base of the carapace. The anterior row of eyes is curved downward and the clypeus is as high as the diameter of the AME. The surface of the carapace

is free of hair except for a few short ones along its edge in the posterior region.

The chelicerae are partly damaged by polishing and partly covered with emulsion. Only the anterior edge of the maxillae is visible. The sternum, although covered with emulsion, can be seen in certain light (Fig. 286). It is flat, distinctly longer than wide, triangular, with lateral excavations for the coxae and is quite pointed between the hind coxae. The first coxae are wide apart. No spur or hook can be seen on any coxa. The legs are fairly short and stout and quite spinose (Fig. 288).

Leg formula	1	2	4	3		
	3.9	3.1	2.8	2.2		
	Femur	Pat. + Tib.	Metat.	Tarsus	Total	
I	2.60	2.92	2.40	0.72	8.64	
II	2.00	2.20	2.00	0.72	6.92	
III	1.52	1.40	1.20	0.68	4.80	
IV	1.80	2.00	1.60	0.68	6.08	

Width of first patella 0.312 mm. First tibial index 11.

*Spines.* First leg. Femur dorsal 1-1-1, prolateral 0-1-1, retrolateral 0-0-1, ventral 1. Patella dorsal 1-1, first a bristle, prolateral 0, retrolateral 1 stout spine, ventral 0. Tibia dorsal 1-0-1, prolateral 1-1-1, retrolateral ? (view obstructed by emulsion), ventral 0-2-2. Metatarsus dorsal 1-0, prolateral 0-1, a very small apical spine, retrolateral 1-1-1, ventral 0.

Second leg same as first except tibia ventral 0-0-2, metatarsus prolateral 0, retrolateral 1-1-0.

Third leg. Femur dorsal 1-1-1, prolateral 0-0-1, retrolateral 0-0-1, ventral 1. Patella dorsal 1-1, the first a long bristle, retrolateral 1, elsewhere 0. Tibia dorsal 1-0-0, prolateral 0-1-1, retrolateral 0-1-1, ventral 2-0-2. Metatarsus dorsal 0-1, retrolateral 1-0, elsewhere 0. Fourth leg same as third, except tibia dorsal 1-1, prolateral 0, retrolateral 0-1-1, ventral 2-2. Metatarsus dorsal 1-1, elsewhere 0.

Most of the spines stand at considerable angles to the axis of the leg giving it a very spinose appearance.

Three claws. Upper claws (Figs. 283 and 284) somewhat dissimilar. Proclaw slightly more bent and with six teeth which increase in length rapidly so that the distal tooth is several times longer than the basal tooth. Retroclaw is more evenly curved and

has only three teeth. The third claw is smooth, very strongly curved. At least one pair of typical spurious claws may be seen under the claws. On one of the tarsi a peculiar bristle is also present ending in three branches as shown in Fig. 283. Trichobothria few and difficult to see. There are none on any femur. On the first tibia one can see a row of several trichobothria. None can be seen elsewhere. The legs are clothed with simple, stiff hair having almost the appearance of bristles.

The abdomen is ovoid, clothed with long brown bristles giving it a peculiar appearance like a porcupine. With the spinnerets the abdomen is 2.6 mm. long, 1.6 mm. wide. On the dorsal surface of the abdomen the four muscle disc attachments are plainly visible forming a regular trapeze. The posterior end of the abdomen is with distinct transverse plications, suggesting segmentation. The anal tubercle is cone-shaped and fairly large. The spinnerets (Fig. 287) are arranged in a typical rosette. The anterior pair are cone-shaped, separated by a distinct colulus. The posterior spinnerets have the same shape, but are somewhat shorter, more slender and separated by the full width of the anal tubercle. The median pair cannot be seen.

The palpi (Fig. 282) are clearly visible. Their femur is 0.8 mm. long and is longer than the combined length of the patella and tibia. The patella has two dorsal bristles, one behind the other, so that it falls in the group of *Araneinae* with a single apical bristle on the patella. The cymbium is large and almost circular with a conspicuous retrolateral apophysis at base, best visible from in front. The tibia has no apophysis of any kind, but is supplied with several very long, curved bristles. The bulb has a stout, black hook, but the embolus cannot be seen.

*Eustaloides succini* n. sp. Plate LXII, Fig. 567, Plate XIII, Figs. 117 to 123.

British Museum, Klebs 522, No. 13438, In. 18764.

A well preserved specimen in clear amber. The abdomen coated on both sides with white emulsion. Color of chitin: carapace dark yellow with indication that the head may have been much darker. Sternum and maxillae yellowish brown. Palp yellow with almost black copulatory apparatus. Legs yellow. Abdomen light yellow.

Type. Mature male. Total length 4.5 mm. Carapace approximately 1.98 mm. long, 1.98 mm. wide between second and third

coxae, where it is widest, considerably narrowed in front where in the region of the posterior row of eyes it is only 1.00 mm. wide. The head is clearly set off from the thorax and almost on the same level with it. Thoracic groove longitudinal. The posterior declivity is steep, although the carapace is rather low. A few bristles are on the head at the sides of the eyegroup and behind it, but the rest of the carapace is without any pubescence. The eyegroup is not quite as wide as the head, being only 0.64 mm. wide. The anterior row of eyes (Fig. 123) is strongly recurved, the posterior row very slightly procurved and a little longer. The AME are very prominent. The lateral eyes are contiguous on a common tubercle. Ratio of eyes AME: ALE: PME: PLE = 9:9:5:6. The AME project beyond the clypeus and are separated from the lateral eyes by a deep cleft. The eyes of the posterior row are separated from each other by their diameter. The quadrangle is square. The clypeus is equal to the radius of the AME.

The chelicerae are rather long, converging, but on account of reflections can be seen only in face view and then with difficulty. The fangs are short and stout. The lip (Fig. 117) is wider than long, narrower at base than in middle, distinctly rebordered. The maxillae are much wider in front than at the base. The outer surface of the maxillae forms almost a right angle with the front surface and is drawn out into a pointed angle. The sternum is triangular, much longer than wide, in ratio 30:21, flat, quite pointed between the hind coxae which are separated by about one-quarter of their width. Anteriorly the sternum is distinctly emarginate for the accommodation of the lip. It is sparsely clothed with long bristles. The first coxae are wide apart and the first and second coxae are distinctly stouter than the third and fourth coxae. None of the coxae have either a hook or a spur.

Leg formula	1	2	4	3
	4.6	3.8	3.3	2.6

	Femur	Pat. + Tib.	Metat.	Tarsus	Total
I	2.60	3.00	2.60	0.88	9.08
II	2.20	2.40	2.12	0.76	7.48
III	1.68	1.60	1.24	0.56	5.08
IV	2.00	2.08	1.60	0.76	6.44

Width of first patella 0.384 mm. First tibial index 12.8.

Width of fourth patella 0.264 mm. Fourth tibial index 12.7.

The legs are spinose (Fig. 118). The spines are long and stand at considerable angles to the longitudinal axis of the leg. First leg. Femur dorsal 0-1-1, prolateral 0-1-1, retrolateral 0-1-1, ventral 0. Patella dorsal 0-1, retrolateral 1, elsewhere 0. Tibia dorsal 1-1-1, prolateral 0-1-1, retrolateral 1-1-1, ventral 0-2-2. Metatarsus dorsal 1-1, prolateral 1-1, elsewhere 0. Second leg same as first.

Third leg. Femur dorsal 0-1-1, prolateral 0-0-1, retrolateral 0-1-1, ventral 0. Patella dorsal 1-1, retrolateral 1, elsewhere 0. Tibia dorsal 0, prolateral 0-1-1, retrolateral 0-1-1, ventral 0-2-2. Metatarsus dorsal 1-1, elsewhere 0.

Fourth leg. Femur dorsal 1-1-1-1, prolateral 0-0-1, retrolateral 0-0-1, ventral 0. Patella dorsal 1-1, retrolateral 1, elsewhere 0. Tibia dorsal 1-1-1, prolateral 1-0-1, retrolateral 1-1-1, ventral 1-1-2. Metatarsus dorsal 1-0, prolateral 0-1, retrolateral 1-1, ventral 0.

The legs are sparsely clothed with fine hair. Scopulae and clawtufts wanting. Three claws. Upper claws (Fig. 122) similar, bent, with a row of five teeth. Third claw bent at right angles, smooth. Trichobothria difficult to see and while some are visible, their arrangement remains uncertain. Besides the fine hair mentioned above, there is another type of hair present on the tibiae, metatarsi and tarsi. This type of hair (Fig. 119) is especially noticeable on the tarsi where the individual hairs are evenly spaced. They are shorter than the other type and stand at right angles to the longitudinal axis of the tarsus. Also each hair is bent backward at its tip.

The abdomen is ellipsoidal, slightly flattened above. It is 2.7 mm. long, 2.1 mm. wide, clothed with long bristles sticking out through the white emulsion which covers the surface of the abdomen. On the ventral surface the emulsion is thinner and one can see that here the abdomen is clothed with comparatively short hair. The spinnerets are arranged in a rosette and there is a small colulus in front of the anterior pair which is contiguous.

The palpi (Figs. 120 and 121) show very long retrolateral bristles on the tibiae. The bristles on the patella are placed diagonally so that it is difficult to say whether they represent a pair or a sequence. However, even the more advanced bristle is not apical. The tibia has a very short apophysis at the end. The terminal joint is large. The cymbium has a trapeze-shaped basal apophysis. The copulatory apparatus is quite complex, as shown in the figures. The embolus is in the shape of a fine, curved needle.

Subfamily *Metinae*

To this subfamily I refer three new genera: *Acrometa*, *Theridiometa* and *Memoratrix*. Each of these genera is represented by a single species, but whereas the first two seem to have been very common, the third is represented by a single specimen. In my Key to Subfamilies of *Argiopidae* published in the Catalogue of American Spiders the chief character separating the *Metinae* and *Theridiosomatinae* from the *Araneinae* is the presence of a well developed boss in the chelicerae of the latter and its absence or rudimentation in the former. This character was first used by F. O. P. Cambridge, but is not a very reliable one especially in amber spiders which rarely show the boss to advantage. Simon knew that character, but placed the *Meteae* in the Subfamily *Tetragnathinae* which are now recognized as a distinct subfamily by all arachnologists. For him the *Meteae* represented a transitional group between the *Tetragnatheae* and the *Araneinae*. In a sense they are, inasmuch as they have rather slender legs, less spinose, less powerful chelicerae, not as heavily built body, etc. But their external genital organs are as highly developed and complicated as those of *Araneinae*. Of the 17 genera of *Metinae* listed in my Systema a few probably will have to be removed to some other subfamily. The new fossil genera are distinct from all recent ones of the same subfamily. Nevertheless, in some respects they rather add to the difficulty of defining the subfamily. Especially *Theridiometa*, as the name implies, shows a mixture of characters of two families. When the classification of the Family *Argiopidae* is better understood then it will be time to reconsider the position of the fossil genera.

## Key to the fossil Genera

1. Carapace greatly narrowed in front, more than twice as wide as the eyegroup. Promargin of chelicerae with three teeth ..... *Acrometa*.
- \* Carapace less narrowed in front, not more than twice as wide as the eyegroup ..... 2
2. Promargin of chelicerae with three teeth. First leg not more than four and one-half times as long as the carapace ..... *Theridiometa*.
- \* Promargin of chelicerae with a single tooth. First leg nine times as long as the carapace ..... *Memoratrix*.



Genus *Acrometa*, nov

Carapace greatly narrowed in front, more than twice as wide as the eyegroup. AME contiguous, larger than the others. Lateral eyes on a common tubercle. Anterior row of eyes strongly recurved. Posterior row slightly recurved. Quadrangle wider behind than in front and wider than long. Chelicerae without boss, with oblique margins. Promargin with three teeth. Lip wide. Maxillae diverging in front. Sternum flat, shield-shaped. First coxae wide apart. None of the coxae with a hook or spur. First leg nearly five times as long as carapace. Order of legs 1243. Three claws. Upper claws similar, bent, with three or four teeth. Abdomen of the male theridioid. Male palp with spiral, long and fine embolus. Type *A. cristata*.

*Acrometa cristata* n. sp. Plate LIX, Figs. 541 to 546. Plate IX, Figs. 76 to 82. Plate LV, Fig. 516.

The British Museum has seven specimens of this species, all mature males:

1. In. 18724, Klebs 481, No. 13408. Type. Figs. 77 and 545.
2. In. 18713, Klebs 467, No. 13430. Paratype. Figs. 79, 81 and 546.
3. In. 18728, Klebs 485, No. 13458. Paratype. Figs. 78 and 542.
4. In. 18750, Klebs 508, No. 13453. Paratype. Figs. 82 and 543.
5. In. 18752, Klebs 510, No. 13461. Paratype. Figs. 76, 80, 516, 541.
6. In. 17845, Collection from Samland. Fig. 544.
7. In. 18157, Collection from Samland.

The U. S. National Museum has one specimen—a mature male

All eight specimens undoubtedly belong to the same species and are approximately of the same size. The structure of the palp is the same. The best preserved specimen In. 18724 was chosen as type. Four other specimens are designated as paratypes. Of these In. 18713 shows the structure of the palp from in front best of all. In. 18752 shows the crest and the palp in side view. In. 17845 shows the posterior end of the sternum. In. 18750 shows the lip and maxillae. In. 18728 shows the spinnerets. The color of the chitin in all specimens is about the same: from light to dark brown, abdomen buff.

Description of type, with reference to other specimens.

Type. Mature male. Total length 2.6 mm. Carapace (similar to that shown in Fig. 76 for specimen In. 18752) 1.4 mm. long, 1.2 mm. wide opposite second coxae where it is widest. It is narrowed in front to the width of the eyegroup which is 0.5 mm. The thoracic groove is in the shape of a deep depression at the bottom of which a short longitudinal line is visible. The head is somewhat elevated above the thorax, but the general impression is that of a flat carapace. A median crest of stout curved bristles directed forward extends from the thoracic groove to the anterior edge of the eyegroup. This crest gives a peculiar and characteristic appearance to the spider. The anterior median eyes project beyond the clypeus. The height of the face from the top to the edge of the chelicerae is as great as the length of the basal joint of chelicerae.

The eyegroup is composed of eight eyes and is similar to that shown in Fig. 79 for specimen In. 18713. The anterior row is strongly recurved. The posterior row is gently recurved and only a little longer. The lateral eyes are contiguous, on a common tubercle. The AME are also contiguous and a little larger than the other eyes. The quadrangle is wider behind than in front in ratio 11:8, wider than long in ratio 11:9. The distance between the AME and ALE is somewhat less than the diameter of the eye. The PME are separated from each other by twice their diameter. The clypeus is equal to two diameters of the AME. It is clothed with stiff, long brown hairs directed forward.

The chelicerae are relatively short and stout (Fig. 77). The margins are oblique. The promargin has three teeth of which the proximal one is the largest. The retromargin cannot be seen in any of the specimens. The fang is slender, curved and rather short.

The lip and maxillae are similar to those in specimen In. 18750. Here they are quite clearly visible. The lip is wider than long, lenticular, with a procurved suture and a rounded front. The anterior edge is strongly rebordered. The lip does not reach the middle of the maxillae. The maxillae are wide in front, their inner edges are first parallel to each other, then become divergent. The serrula is plain visible.

The sternum is shield-shaped, distinctly convex, as long as wide in the widest place which is behind the first coxae. It has a distinct excavation for the reception of the lip. Posteriorly it is

pointed between the hind coxae which are separated by more than one-half of their width. The first coxae are wide apart. None of the coxae has any hook or spur. The surface of the sternum is clothed with stout brown hair.

Leg formula	1	2	4	3	
	4.8	3.9	3.4	2.6	
	Femur	Pat. + Tib.	Metat.	Tarsus	Total
I	2.00	2.40	1.70	0.60	6.70
II	1.70	1.60	1.50	0.60	5.40
III	1.20	1.10	0.90	0.50	3.70
IV	1.40	1.50	1.20	0.60	4.70

True spines are wanting. The legs are clothed with long and stiff hair having almost the appearance of bristles. The usual dorsal bristles are present on the patella 1-1 and a single one on the tibia a little beyond middle. A tarsal comb, claw-tufts and scopulae are wanting. Trichobothria are few, in a single row on tibiae and metatarsi. Three claws. Because the legs are flexed in the type specimen the structure of the claws cannot be seen plainly. They are, however, well visible in other specimens and Fig. 516 shows them in specimen In. 18752. Here one can see that the upper claws are similar, strongly bent, with a row of four teeth increasing in length distally. The third claw has a single tooth. Serrated bristles are present under the claws.

The abdomen is distinctly theridioid in shape, short, high, pointed behind, partly overhanging the carapace. It is sparsely clothed with stiff, long, brown bristles giving the abdomen a peculiar appearance. In specimen In. 18752 the maximum length of the abdomen is 1.5 mm. including the spinnerets. This measurement does not represent the morphological length from the petiolus to the anal tubercle, which is only 1.1 mm. The maximum width of the abdomen in that specimen is 1.2 mm. which means that the abdomen is in reality shorter and higher than long.

The spinnerets are poorly visible in all specimens except In. 18728 shown in Fig. 78. Here the pair of anterior spinnerets is plainly visible as well as the complete left posterior and the end of the right posterior spinnerets. The anterior spinnerets are cone-shaped, contiguous and considerably stouter than the posterior pair. The latter are also somewhat shorter and are wide apart at base. The median pair is not visible even in this specimen. A colulus is present between the anterior spinnerets.

The palpi are alike in all specimens to the minutest detail of their structure. Figure 80 shows the left palp of specimen In. 18752 viewed from the underside. Figure 81 shows the front view of the left palp of specimen In. 18713. The terminal joint is very large and its structure is very complicated. The paracymbium is well developed and covered with granules. In a lateral view of the palp two chitinous spirals are visible. The proximal spiral is stouter and forms a complete circle. The distal spiral originates at about the same place as the former, has a much finer base, is much more slender and forms a spiral with two and one-half turns. It is not possible to determine which of the two spirals is the embolus and which is the conductor. The cymbium is clothed with stout hair. Tibia, patella and femur with long, stout bristles especially noticeable on the dorsal surface.

This species shows much resemblance to Koch's *Zilla veterana* if one can judge by the figure and too brief description. The latter is not only inadequate for determination of the species, but contains statements which cannot be reconciled with the characters given here for *Acrometa cristata*.

The specimen in the collection of the U. S. National Museum is also a mature male 2.6 mm. in length. Its first leg is 7.7 mm. long. Its carapace is 1.4 mm. long, 1.2 mm. wide. Both palpi show the spirals. The amber contains a small mite close to the left palp.

#### Genus *Theridiometa*, nov.

Carapace gradually narrowed in front. Head higher than thorax. Thoracic groove wanting. Eyes in two rows. Promargin of chelicerae with three teeth. Lip wider than long, not rebordered. Sternum convex, triangular. First coxae wide apart. Order of legs 1243. True spines wanting, but dorsal bristles present on patella and tibia. Three claws. Upper claws bent, with three or four teeth. Trichobothria on tibiae, metatarsi and tarsi. Abdomen theridioid, hirsute. Type *T. edwardsi*.

#### Key to Species of *Theridiometa*

1. Anterior median eyes slightly smaller than the others, separated from each other by about their diameter.....

*T. edwardsi*.

- \* Anterior median eyes slightly larger than the others, contiguous or nearly so .....

2. Legs fairly slender with first tibial index 9.7. First leg four and one half times as long as carapace ..... *T. samlandica*.
- \* Legs stouter, with first tibial index 15. First leg only 3.4 times as long as carapace ..... *T. robusta*.

*Theridiometa edwardsi* n. sp. Plate LIX, Fig. 551, Plate LX, Fig. 555, Plate XI, Figs. 103 to 107, Plate XLVII, Figs. 442 to 445, Plate LXIV, Fig. 587.

Six specimens in the collection of the British Museum. Of these two specimens are mature females, the others are immature and not well preserved.

1. In. 18964, Coll. W. N. Edwards. Type. Figs. 103 to 105 and 551.
2. In. 18768, Coll. Klebs 526, No. 13417. Paratype. Figs. 106, 107, 555.
3. In. 18121, Coll. from Samland. Figs. 442 to 445, and 587.
4. In. 18140, Coll. from Samland.
5. In. 18142, Coll. from Samland.
6. In. 18148, Coll. from Samland.
7. In. 18126, Coll from Samland.

*Type.* Mature female. A well preserved specimen in clear amber. Color of chitin: carapace and legs light brown with a yellowish tinge. Abdomen light grey, considerably lighter than carapace. Chelicerae, lip and maxillae rufous.

Total length 2.6 mm. The carapace is so hidden from view by the legs and the abdomen that measurements cannot be made. Its highest point is far behind the eyes. It slopes forward gradually. There are three rows of bristles on the carapace, one of which is mid-dorsal, the others flank the head. Eight eyes in two rows. The anterior row is recurved, the posterior row is also recurved, but not as much. The lateral eyes are contiguous, on a common tubercle clearly separated from the median eyes. The AME are also on a common tubercle, but are separated from each other by about their diameter. All eyes seem to be of about the same size. The quadrangle as far as visible looks square. The view of the face is badly distorted by a plane of cleavage in the amber, so that in some

positions the clypeus appears to be very high and in others quite low. This distortion of the image must be taken into account in comparing the height of the clypeus with the size of the AME. I think it safe to assume that the clypeus is at least as high as their diameter, possibly a little higher.

The chelicerae (Fig. 105) are fairly stout, without boss, with oblique margins. Promargin with three pointed teeth the median tooth largest. Retromargin smooth. The fang is slender, evenly curved. The maxillae are black, very convex, strongly converging over the lip. The lip is free, wider than long, rounded in front, not rebordered. The sternum is triangular and distinctly convex, wider than long, the width being equal to the length of the side. It is clothed with stout, erect bristles. The first coxae are very wide apart. The fourth coxae are separated a little by the posterior point of the sternum. Order of legs 1243.

	Femur	Pat + Tib	Metat.	Tarsus	Total
I	1.72	1.88	1.32	0.69	5.61
II	1.48	1.48	0.96	0.55	4.47
III	0.92	0.92	0.69	0.50	3.03
IV	1.28	1.28	0.88	0.48	3.92

Width of the first patella 0.144 mm. First tibial index 7.6.

Width of the fourth patella 0.144 mm. Fourth tibial index 11.

The legs are distinctly setose. One can see on all legs the usual dorsal bristles 1-1 on the patella and 1-1 on the tibia. A comb of serrated bristles is wanting, but the ventral row of plain bristles may be easily mistaken for one in certain positions. However, these bristles lack serrations and are in no way different from other setae. The trichobothria are smaller than the hair and may be studied only under high power. There are three trichobothria in a row on the tibia increasing in length distally. The first of these is quite small and is situated near the middle of the tibia. The third is much longer and is situated about one-third of the full length of the tibia from its anterior end. On the first metatarsus a single trichobothrium is visible slightly before middle, but on the third metatarsus a row of three trichobothria is present, the middle one being the longest. A single trichobothrium may be also seen on the third tarsus.

Three claws (Fig. 103). Upper claws similar, bent, with four

teeth increasing in length distally. Third claw bent at right angles, smooth. Claw-tufts, spurious claws and scopulae wanting.

Abdomen theridioid, almost globular, 1.4 mm. long. It is clothed with long bristles. Six spinnerets arranged in a rosette. A distinct colulus present in front of the anterior spinnerets. The epigynum (Fig. 104) is prominent and has the shape of a transverse, very dark plate constricted in middle.

The palp is distinguished by the extraordinary length of the terminal joint which is at least twice as long as the tibia and is covered with long bristles. At the end a single, curved, long claw is present.

*Paratype.* Mature female. A perfectly preserved specimen, In. 18768, in clear amber containing many pollen grains. Abdomen coated with white emulsion. Color of chitin: carapace, chelicerae and legs buff, carapace slightly darker than the legs. Abdomen lighter.

Total length including chelicerae 2.4 mm. Carapace 1.6 mm. long, 1.52 mm. wide between second and third coxae where it is widest, considerably narrowed in front (Fig. 106) where it is only 0.84 mm. wide in the region of the eyes. The carapace is flat, the head clearly higher than the thorax and with almost parallel sides. Thoracic groove wanting. Three rows of brown bristles, each row composed of five or six bristles, extend from end to end of the head. The eyegroup is narrower than the carapace in that region. The anterior row of eyes is recurved, the posterior row straight and slightly longer. Total width of the eyegroup 0.76 mm. All eyes of about the same size. AME separated from each other by a little less than their diameter. PME separated from each other by their diameter and by a little less than their diameter from the PLE. AME on a small, common tubercle. Lateral eyes contiguous, on a common tubercle. Quadrangle wider behind than in front in ratio 10:8, wider than long in ratio 10:9. Clypeus equal to one and one-half diameters of the AME.

The chelicerae are rather short and stout, without boss, with oblique margins, with a few bristles on the anterior surface. Promargin with three teeth. Maxillae, lip and sternum coated with white emulsion. However, one can clearly see that the sternum is triangular. First coxae wide apart. Fourth coxae separated from each other by their width.

Leg formula	1	2	4	3
	3.3	2.7	2.5	1.9

	Femur	Pat + Tib.	Metat.	Tarsus	Total
I	1.60	1.68	1.16	0.76	5.20
II	1.40	1.40	1.00	0.56	4.36
III	0.92	0.88	0.68	0.52	3.00
IV	1.40	1.20	0.80	0.52	3.92

Width of first patella 0.140. First tibial index 8.3.

Fourth femur distinctly curved dorso-ventrally. The shape of the first patella (Fig. 107) is rather unusual. Its inner edge (pro-lateral) is concave, its outer (retrolateral) edge is distinctly angular and bears a bristle at its apex. The legs are clothed with stout setae assuming the aspect of stout bristles in some places as on the dorsal surface of the patella and tibia. Trichobothria difficult to see. There is a row of three on the tibia, the first in the middle of the joint, the last one third from apical end. These trichobothria increase in length distally. I am unable to recognize trichobothria elsewhere. Tarsal comb, scopulae, spurious claws and claw-tufts wanting. Three claws. Upper claws similar, with three or four teeth increasing in length distally. Third claw bent at right angles, smooth. Palpi of the female type.

Abdomen theridioid, as high as long, clothed with short hair and long, brown bristles. Spinnerets and genital region hidden from view by emulsion.

*Specimen In. 18121.* Immature female. Figs. 442 to 445 and 587. A fairly well preserved specimen in very poor amber full of reflections and air pockets. As a result the heat of the lamp used as a source of light caused a split across the specimen. Total length 2.46 mm. Carapace 1.07 mm. long, 0.87 mm. wide in its widest place, 0.55 mm. wide in the region of the eyes. Thoracic groove visible, longitudinal, fine. The carapace is fairly high. The highest point behind the middle. It slopes down and then rises again so that the head is on a level with the thorax. Posterior declivity steep. Eight eyes in two rows. Anterior row recurved. Posterior row less recurved and longer. Width of eyegroup 0.53 mm. Ratio of eyes AME:ALE:PME:PLE = 7:8:8:8. AME separated from each other by their diameter and by a little more from the ALE. PME separated from each other by three-eighths



of their diameter and by almost twice that distance from the PLE. Quadrangle rectangular. Chelicerae (Fig. 444) stout, with oblique margins. Promargin with three teeth. Maxillae convex, with widely truncated front provided with a curved serrula. First coxae wide apart. Legs setose, with usual dorsal bristles. Three claws. Upper claws similar, with teeth. Palp with smooth claw. (Fig. 455.) Abdomen globose.

*Specimen In. 18126.* A poorly preserved, very young specimen in dark brown amber full of air pockets. Ventral surface polished off by the previous owner.

Total length with chelicerae 2.2 mm. Carapace narrowed in front. All eyes same size. Lateral eyes on a common tubercle. AME separated by slightly more than their diameter. PME separated by  $8/5$  of their diameter. Clypeus one and one-half diameter of AME. Sternum convex, triangular, as long as wide. First coxae wide apart. Legs in order 1243.

	Femur	Pat. + Tib.	Metat.	Tarsus	Total
I	1.12	1.28	0.80	0.64	3.84
II	1.00	1.08	0.64	0.48	3.20
III	0.68	0.64	0.44	0.28	2.04
IV	0.96	0.88	0.52	0.40	2.76

Fourth femur somewhat curved dorso-ventrally. Legs setose. Usual dorsal bristles present. Three claws. Palp of the female type. Abdomen theridioid, with long brown bristles.

*Theridiometa samlandica* n. sp. Plate LXVI, Fig. 594, Plate XXXVII, Figs. 351 to 353. Plate LXV, Fig. 588, Plate XXXV, Figs. 338 to 340.

Two specimens, one an immature female, the other an exuvium, both in the collection of the British Museum.

Type. In. 18132, from Samland, Figs. 351 to 353 and 594. Immature female. A well preserved specimen in fairly clear amber which has a plane of cleavage with an air layer, but free of emulsion. The abdomen displaced at an almost acute angle to the carapace. Color of chitin rufous with a greenish tinge. Total length expressed as sum of two measurements, approximately 2.2 mm. Carapace 1.32 mm. long, ca. 0.96 mm. wide, narrowed in front to 0.60 mm. in the region of the eyes. Viewed from the side the carapace appears to be fairly high with a rather steep

posterior declivity. The highest point is in the region of the thoracic groove, but the head is almost as high. Eight eyes, very prominent (Fig. 351). Anterior row recurved, posterior row pro-curved and slightly longer. Ratio of eyes AME:ALE:PME:PLE = 5:4:4:4. AME on a common tubercle, contiguous, slightly separated from the lateral eyes which are contiguous and on a common tubercle. PME separated from each other by three-quarters of their diameter and by the same distance from the PLE. Quad-rangle square. Clypeus (Fig. 352) equal to three-fifths of the diameter of AME.

Chelicerae without boss. Basal joint 0.60 mm. long. Margins oblique, barely visible through the emulsion. The fang is short and weak. The maxillae are more or less parallel, wide in front. The sternum is triangular, shiny, slightly convex. The first coxae are wide apart.

Leg formula	1	2	4	3
	3.4	2.6	2.3	1.8

	Femur	Pat. + Tib.	Metat.	Tarsus	Total
I	1.40	1.40	1.08	0.56	4.44
II	1.12	1.12	0.80	0.44	3.48
III	0.80	0.72	0.52	0.36	2.40
IV	1.00	1.00	0.72	0.36	3.08

First and second femora much stouter than third and fourth femora. True spines wanting, but usual dorsal bristles present on patellae and tibiae. Some are also on the femora and metatarsi (Fig. 353). A row of three trichobothria may be seen on the tibiae, but not elsewhere. Three claws. Upper claws toothed, but their structure cannot be seen. Third claw strongly bent. Tarsal comb, claw-tufts, scopulae and spurious claws wanting. The legs are sparsely clothed with hair almost of the appearance of bristles.

The abdomen is theridioid, 1.6 mm. long, 0.9 mm. high, 1.0 mm. wide, clothed with stout, curved, brown bristles. The spinnerets are best visible in side view. The anterior pair is stouter, but of the same length as the posterior pair. The terminal joint of the palp is slightly stouter than the tibia.

*Specimen In. 17629.* (Seeböhm's Bequest.) Figs. 338 to 340 and 588. An exuvium in perfectly clear amber. The ventral surface heavily coated with white emulsion. The carapace, separated from the sternum along its edge, is still connected with the abdomen

by the petiolus. It is otherwise intact and perfectly visible from the outside and from the inside. The abdomen is completely shrivelled as is usual with exuvia. Its bristles stand out in all directions. The sternum can be seen only from the inside. The total size of the spider can be only guessed and is between 2.5 and 2.7 mm. The color of the chitin is yellow, like gold. Chelicerae somewhat darker. There is no question but that this is an exuvium. Probably it was blown by the wind and became entangled in the gum.

Carapace 1.0 mm. long (Fig. 338), 0.84 mm. wide in its widest place. Anteriorly the carapace converges in a curve to the width of the eyegroup which is 0.76 mm. Posterior declivity short and rather gradually slanting. The head is delimited by the sulci. A stout, long bristle is at the posterior end of the head. Two bristles, one behind the other in the middle line in the eye region, one bristle in front of each AME and two bristles in front and slightly below each lateral eye, making altogether nine bristles. There are in addition a few short bristles in the cephalothoracic sulci as shown in the figure. Eight eyes in two rows (Fig. 339). The anterior row is recurved, the posterior row much less recurved and slightly longer. Ratio of eyes AME:ALE:PME:PLE = 6:5:5:5. AME contiguous, on a common tubercle. Lateral eyes are also contiguous, on a common tubercle. The PME are separated from each other by their diameter and from the PLE by three-fifths of their diameter. A single bristle is on the clypeus below the median eyes and a transverse row of four bristles near the edge. The chelicerae are distinctly geniculated. A portion of a scopula and the rather slender, curved fangs are visible, but nothing more can be made out.

The sternum is as wide as long. The first coxae are wide apart.

Leg formula	1	2	4	3
	4.5	3.6	3.2	2.7

	Femur	Pat. + Tib.	Metat.	Tarsus	Total
I	1.40	1.48	1.00	0.60	4.48
II	1.08	1.16	0.84	0.56	3.64
III	0.96	0.68	0.56	0.52	2.72
IV	1.04	1.08	0.72	0.36	3.20

Width of first patella 0.144 mm. First tibial index 9.7.

Second right leg was autotomized in life as evidenced by the surface of the coxa. True spines wanting, but usual dorsal bristles

present on patella and tibia. Three claws. Upper claws similar, bent, with four teeth increasing in length distally. Third claw smooth. The legs have a setose appearance. There is in addition to the regular hair a prolateral and a retrolateral row of short, erect little spines on the first and second tibia and metatarsus. Their number is quite small and they are more or less evenly spaced.

The palp is of the female type. It originates at the base of the maxilla. The femur is about as long as tibia + patella which are of the same length. The terminal joint is as long as the femur. There are two dorsal bristles, 1-1, on the patella and one on the tibia. The hair on the terminal joint is quite setose.

On account of the greatly shrivelled condition of the abdomen its shape cannot be determined. It was clothed with long, stout bristles which are visible and agree in appearance with those of the type.

*Theridiometa robusta*, n. sp. Plate LXIX, Fig. 621.

Crosby Collection, Cornell University, No. 8.

A single specimen in fairly clear amber which, however, has a plane of cleavage full of reflections. There is also some white emulsion on the abdomen and on the mouthparts. The color of the chitin is a very light yellow, the abdomen almost white. Pullus. Type. Total length 1.56 mm. Carapace 0.70 mm. long, 0.60 mm. wide between second and third coxae where it is widest, narrowed in front almost to the width of the eyegroup. Thoracic groove wanting. The carapace is fairly high, the highest point approximately two-fifths from posterior margin. It slopes down from here forward gradually and backward much more rapidly. Eight eyes in two rows. Anterior row recurved. Posterior row straight. AME projecting beyond the clypeus. Lateral eyes on a common tubercle. Ratio of eyes AME:ALE:PME:PLE = 3:2.5:2.5:2.5. Quadrangle square. Lateral eyes contiguous. AME on a common tubercle, not contiguous, but the distance between the eyes cannot be measured because the view is obstructed by the legs. The PME separated by at least their diameter and by a little less from the PLE.

The lip is much wider than long. The maxillae are slightly inclined over the lip, much wider in front than at base. The palp is inserted near the base of the maxilla. The sternum is convex, more or less triangular, with curved sides, longer than wide in

ratio 9:8. It is shiny, with just a few stout hairs. The first coxae are wide apart. The fourth coxae are separated by their width.

Leg formula	1	2	4	3
	3.4	2.7	2.4	1.9

	Femur	Pat. + Tib.	Metat.	Tarsus	Total
I	0.70	0.79	0.53	0.34	2.36
II	0.60	0.58	0.41	0.31	1.90
III	0.41	0.41	0.26	0.24	1.32
IV	0.53	0.58	0.34	0.26	1.71

Width of first patella 0.120 mm. First tibial index 15.

Width of fourth patella 0.100 mm. Fourth tibial index 17.

Spines wanting, but usual dorsal bristles present on patella 1-1, on tibia 1-1. Legs clothed with simple hair more numerous on metatarsi and tarsi than elsewhere. A single row of five or six long hairs on the femur in a retroventral line. Tarsal comb, scopulae, claw-tufts and spurious claws wanting. Trichobothria few and difficult to see. One can see two on the tibia and one in the middle of the metatarsus. Three claws. Upper claws similar, with five or six long teeth. Third claw bent at right angles, smooth, about as long as the upper claws.

The abdomen is ovoid, pointed behind, 0.86 mm. long, 0.70 mm. wide, sparsely clothed with long bristles. The spinnerets are poorly visible, but are undoubtedly arranged in a rosette. Anterior pair stouter and longer than posterior pair. The median pair is not visible, nor can it be determined whether a colulus is present or wanting.

#### Genus *Memoratrix*, nov.

Carapace low, narrowed in front to the width of the eyegroup. Head clearly delimited by the sulci, on a level with the thorax. Eight eyes in two rows. Anterior row recurved, posterior row slightly procurved. All eyes of the same size. AME on a common tubercle separated from each other by about their diameter. Lateral eyes subcontiguous, on a common tubercle separated from the tubercle of the AME by a deep cleft. Quadrangle almost square. Clypeus high. Chelicerae without boss, with almost transverse margins. Promargin with a single tooth. First coxae wide apart. Legs long and slender. First leg nine times as long as the carapace. Order of legs 1243. Spines on legs present.

Three claws. Upper claws similar, toothed. Abdomen ellipsoidal, of the *Leucauge* type. Trichobothria wanting on the femora. Type *M. rydei*.

(Derivation of name: Latin—memoratrix—she who relates.)

*Memoratrix rydei*, n. sp. Plate LXV, Fig. 589. Plate XXIII, Figs. 212 to 218.

A single specimen in the collection of the British Museum, In. 27369, collection of C. Ryde in whose honor the species is named. It is a fairly large specimen in a piece of amber of very peculiar shape making the study difficult. Although the amber is clear, the abdomen is coated with white emulsion which is also found on all legs. The first left, both second right and third right legs are complete. The other legs were partly cut off in polishing by a previous owner. Fortunately of the fourth left leg the femur, part of the metatarsus and the tarsus are present while the patella and tibia are missing, and of the fourth right leg part of the femur, the metatarsus and tarsus are present, while the patella and tibia are also missing. Of the first right leg the femur is complete as well as the patella. A portion of the tibia remains. The third left leg is cut off beyond the base of the metatarsus.

Type. Mature female. Total length 5.7 mm. Carapace 2.45 mm. long, 1.8 mm. wide between second and third coxae where it is widest, narrowed down in front (Fig. 214) to less than the width of the eyegroup. The thoracic groove is very deep, in the shape of a long ellipse. The head is clearly delimited by the sulci which are rather deep. In side view the carapace appears to be rather low (Fig. 212) and the head is on a level with the thorax. Viewed from above the eyes appear projecting beyond the edge of the head. However, in face view (Fig. 215) it is clear that the ventral margin of the head is wider than the eyegroup. The width of the face is 1.08 mm., while the width of the eyegroup is 0.91 mm.

Eight eyes in two rows (Fig. 218). AME on a common tubercle, and are separated from each other by about their diameter. This tubercle is separated from the tubercles carrying the lateral eyes by deep clefts. The lateral eyes are subcontiguous. The anterior row of eyes is recurved, the posterior row gently procurved. All eyes of about the same size. Quadrangle almost square, or to be exact, wider behind than in front in ratio 19:18, longer than wide

in ratio 20:19. The clypeus is concave under the eyes, convex lower down. Its height equals two diameters of the AME.

The chelicerae (Fig. 215) are parallel, fairly long. The basal joint is 1.00 mm. long. A boss is wanting. The margins are almost transverse. The promargin has a single tooth and a few hairs forming an exceedingly scanty scopula. The retromargin is not visible. The fang is short, slightly curved. The maxillae and lip cannot be seen. The sternum is only very imperfectly visible, partly because of the emulsion obstructing the view, partly because of the position of the palpi and second tarsi. The first coxae are very far apart. The legs are long and slender. The first leg is nine times as long as the carapace. There are very long, erect hairs on the ventral surface of the femora (Fig. 217), but they are of the common, simple kind. There are no trichobothria on the femora. This is an important fact because it precludes the possibility of the spider being related to *Leucauge* with which it has a general appearance in common.

Leg formula	1	2	4	3		
	9.5	7.4	5.6	3.9		
	Femur	Pat. + Tib.	Metat.	Tarsus	Total	
I	6.18	7.12	7.12	2.85	23.27	
II	5.22	5.40	5.40	2.10	18.12	
III	3.32	3.32	2.10	0.90	9.64	
IV	4.27	4.70	3.00	1.80	13.77	

The figures given here for the length of the third metatarsus and tarsus and for the fourth patella and tarsus are only approximate.

The spines are numerous, long, slender and standing out conspicuously. First leg. Femur dorsal 1-0-0, prolateral 1-1-1, retrolateral 0-0-1, ventral a median row of bristles beginning close to base and ending about two-thirds from base, decreasing in length distally. Patella dorsal 1-1, elsewhere 0. Tibia dorsal 1-0-1 first spine near base, prolateral 1-1-1, retrolateral 1-1-1, ventral 0-1, one-third from base. Metatarsus dorsal 1-1-1, prolateral 1-0-0 very close to base, retrolateral 1-1-1, ventral 1-1-1. Second leg. Femur dorsal 1-1-0, prolateral 0-0-1, retrolateral 0-0-1, ventral a median row of bristles similar to but not as many as on the first femur. Patella dorsal 1-1, elsewhere 0. Tibia dorsal 1-0-1, prolateral 1-1-1, retrolateral 0-1-1, ventral 1-1-0. Metatarsus dorsal 1-1-1, prolateral 1-0-0 very close to base, retrolateral 1-1-1, ventral

1-1-1. Third leg. Femur dorsal 1-0-0, prolateral 0, retrolateral 0, ventral a series of bristles of which the first, second and third are very long. Patella dorsal 1-1, elsewhere 0. Tibia dorsal 1-0-1, prolateral 1-1, retrolateral 0-1, ventral 1-0. Metatarsus dorsal 1-1, prolateral 1-1, retrolateral ?, ventral 1-1. Fourth leg apparently same as third. The arrangement of the spines on all legs is not quite regular and cannot be easily expressed in the system of notation adopted here. The legs are clothed with very short, spinose hair. No trichobothria are visible anywhere. Tarsal comb, scopulae, claw-tufts and serrated bristles wanting. Three claws (Fig. 216). Upper claws similar, curved, with a row of fine teeth. Third claw strongly bent, smooth.

The palpi are rather long and comparatively slender. On account of emulsion it is not possible to determine whether a claw is present or wanting. Spine-like bristles of considerable length are present on the patella, tibia and terminal joint.

The abdomen is more or less in the shape of an elongated cylinder, somewhat resembling that of *Leucauge* or *Nephila*. It is clothed with short brown hair visible through the emulsion. The spinnerets, although coated with emulsion are clearly visible. They are arranged in a typical rosette. The anterior pair is contiguous and as long as the posterior pair. The epigynum is very prominent as can be judged from Fig. 212, but so heavily coated with white emulsion that no detail of its structure can be seen.

#### Subfamily *Theridiosomatinae*

##### Genus *Elucus*, nov.

Carapace with steep posterior declivity, gradually sloping downward anteriorly. Head much wider than eyegroup. Quadrangle of median eyes on a slight elevation, square. Lateral eyes on a common tubercle. All eyes about equal. First row recurved, second row slightly procurved. Clypeus as high as the quadrangle. Chelicerae without boss, with oblique margins. Promargin with three teeth. Retromargin smooth. Maxillae very wide in front. Lip wide, strongly rebordered. Sternum very convex, transversely truncated between the hind coxae. First coxae very wide apart. Order of legs 1243. Spines wanting. Three claws. Upper claws similar. Type *E. inermis*.

(Derivation of name: Latin—*elucus*—a drowsy person.)



*Elucus inermis*, n. sp. Plate LX, Fig. 558, Plate XII, Figs. 112 to 116.

A single, well preserved specimen in perfectly clear amber. British Museum, Coll. Klebs 501, No. 13441, In. 18743. The piece had originally an engraving XIIIB441 which had to be polished off to allow clear vision of the spider.

Type. Mature male. Abdomen at right angles to the carapace. Color of chitin: carapace and legs light reddish yellow. Abdomen silvery grey. Venter somewhat lighter.

Total length in the position in which the spider lies in the amber and including chelicerae 3.2 mm. This figure is probably somewhat smaller than the actual total length. Carapace (Fig. 112) ca. 1.45 mm. long, ca. 1.2 mm. wide. Highest point of the carapace just behind the thoracic groove which is transverse and has the shape of a deep pit. The posterior declivity is steep. Anteriorly the carapace slopes downward gradually. The carapace has the shape of an oval. The eyegroup is not as wide as the head. The anterior row of eyes is recurved, the posterior row slightly procurved and a little longer. The quadrangle is square and is elevated above the surface of the head on a low, square platform. The lateral eyes are contiguous, on a common tubercle. All eyes are of about the same size, perhaps the AME a fraction larger than the PME. Total width of eyegroup 0.57 mm. The clypeus is as high as the quadrangle. The carapace is clothed with very short hair.

The chelicerae (Fig. 114) are weak, with parallel outer edges, without boss, with oblique margins. Their armature is visible in strong light against a black background. The promargin has three teeth. The retromargin is smooth. The fang is short, but stout. There is no indication of any stridulating ridges on the chelicerae. The maxillae are much wider in front than at the base. They are very convex and their inner edges converge without meeting, remaining separated by the width of the lip. The anterior surface of the maxillae is transversely truncated and supplied with an almost semicircular serrula. The lip is wider than long and strongly rebordered along its entire anterior edge. The sternum is very convex, sparsely clothed with very fine, but long hair. It is very wide in front, so that the first coxae are wider apart than the combined width of the mouthparts. Posteriorly the sternum is truncated transversely between the hind coxae which are separated

by their width. It is as wide as long. In strong light it has the color of metallic red gold.

Leg formula  $\frac{1}{7.9} \quad 5.9 \quad 5.0 \quad 2.8$

	Femur	Pat. + Tib.	Metat.	Tarsus	Total
I	3.32	3.42	3.32	1.42	11.48
II	2.66	2.56	2.56	0.72	8.50
III	1.00	1.24	1.42	0.44	4.10
IV	2.18	2.00	2.18	0.85	7.21

Width of first patella 0.216. First tibial index 6.3.

Width of fourth patella 0.192. Fourth tibial index 9.6.

The metatarsi and tarsi of all legs are almost twice as slender as the tibiae, and the tibiae twice as slender as the femora. The fourth femur is distinctly curved dorso-ventrally.

True spines on legs are wanting, but the usual dorsal bristles are present, 0-1 on patella, 1-1 on tibia. The legs are clothed with short hair. Tarsal comb, scopulae and claw-tufts wanting. Three claws (Fig. 116). Upper claws similar, slightly bent near the end of the first third and again toward the end. They have a single, pointed tooth. Third claw bent at right angles, with a single tooth. On some of the tarsi two spurious claws are present under the claws. There are no trichobothria on the femora. A single row of short trichobothria is present on the tibia. None on the metatarsi and tarsi.

The abdomen is ovoid, somewhat pointed behind, more or less of a linyphiid type. It is 2.2 mm. long, 1.2 mm. wide a little behind middle where it is widest, clothed with short, very fine hair. Ventral surface without hair. The genital fold is straight, transverse. Six spinnerets arranged in a rosette. The anterior pair (Fig. 113) are contiguous at base, cone-shaped, slightly stouter than the posterior pair. The median spinnerets are small. One can see no spigots on the spinnerets, but the common spinning tubes on anterior and posterior spinnerets have a very long end portion. The anal tubercle is large and as long as the spinnerets. A well developed colulus is present.

The palp is small. Its femur is about half as long as the entire palp. The tibia has no apophysis. The cymbium is much wider at base than at the end, so that it has almost the shape of a triangle. The embolus (Fig. 115) is terminal, slightly curved and pointed.

*Argiopidae Incertae Sedis*

1. *Specimen No. 7* in the Crosby Collection of Cornell University. This is quite a small spiderling, possibly of the first instar. Total length 0.96 mm. Carapace 0.43 mm. long, 0.43 mm. wide, narrowed anteriorly to less than the width of the eyegroup. Eight eyes in two rows. Anterior row recurved. Posterior row procurved and slightly longer. Width of eyegroup 0.22 mm. All eyes of the same size. Lateral eyes contiguous. Quadrangle square. Clypeus as high as the quadrangle.

The chelicerae are parallel, short and rather weak. Margins not visible. Lip short and wide. Maxillae strongly inclined over lip. Sternum very convex, truncated in front, bluntly pointed behind, longer than wide in ratio 15:14. First coxae wide apart. Fourth coxae separated by more than their width. Legs relatively short and stumpy, without spines and with scarcely any hair. But the usual dorsal bristles are present, 1-1 on the patella and 1-1 on the tibia.

Leg formula	4	1	2	3	
	2.8	2.6	2.1	1.9	
	Femur	Pat. + Tib.	Metat.	Tarsus	Total
I	0.38	0.34	0.19	0.21	1.12
II	0.31	0.26	0.16	0.16	0.89
III	0.24	0.26	0.14	0.19	0.83
IV	0.38	0.36	0.24	0.22	1.20

Tarsal comb wanting. Claws very small and difficult to see. Trichobothria few, one on tibia, one on metatarsus.

Abdomen ovoid, 0.60 mm. long, 0.53 mm. wide, 0.53 mm. high. It overhangs the carapace and is sparsely clothed with fine bristles. Six spinnerets arranged in a rosette, cone-shaped. Anterior pair contiguous. Whether a colulus is present or wanting cannot be decided.

2. *Specimen No. 3602b* of the Peabody Museum in Yale University. A very small spiderling in perfectly clear amber. Color of chitin golden yellow. Total length with chelicerae 0.70 mm. Carapace 0.38 mm. long, 0.36 mm. wide between second and third coxae where it is widest, 0.22 mm. wide in the region of the eyegroup. Posterior declivity fairly steep. Eight eyes in two rows. Anterior row strongly recurved. Posterior row slightly procurved

and somewhat longer. Lateral eyes contiguous. Ratio of eyes AME : ALE : PME : PLE = 3.5 : 3.75 : 4.5 : 3.25. Quadrangle wider behind than in front in ratio 12 : 10, wider than long in the same ratio. AME separated from each other by  $4/3.5$  of their diameter and from the ALE by  $1/3.5$  of their diameter. PME are separated from each other by almost their diameter ( $4/4.5$ ) and from the PLE by  $1/4.5$  of their diameter. Clypeus equal to the diameter of the AME. Width of the eyegroup 0.19 mm.

Lip much wider than long. Maxillae strongly inclined over the lip. Palp arises at the base. Chelicerae short and stout, with oblique margins. Fangs slender, curved. Sternum very wide in front, pointed behind, practically an equilateral triangle. It is very convex and the surface is divided into facets. First coxae wide apart. Fourth coxae separated by twice their width. Order of legs 1243.

Leg formula	1	2	4	3		
	3.1	2.5	2.3	2.0		
	Femur	Pat. + Tib.	Metat.	Tarsus	Total	
I	0.37	0.37	0.20	0.23	1.17	
II	0.27	0.27	0.18	0.23	0.95	
III	0.20	0.22	0.14	0.20	0.76	
IV	0.25	0.25	0.18	0.20	0.88	

Spines are wanting, but the usual dorsal bristles are present, 1-1 on patella, 0-1 on tibia. Tarsal comb, scopulae, serrated bristles and claw-tufts wanting. Three claws. Upper claws bent, smooth. Third claw almost as long as the upper ones, bent at right angles, smooth. Trichobothria difficult to see. There is one on the tibia about one-third from base. One on the first metatarsus three-fifths from base. Apparently none on tarsus.

Abdomen almost globular, 0.36 mm. long, sparsely clothed with long, bristle-like hair. Six spinnerets forming a rosette. Anterior pair cone-shaped, subcontiguous, larger than posterior pair. Median pair very small. Anal tubercle small, transversely ellipsoidal. It is impossible to see whether a colulus is present or wanting. Palp of the female type with a long, fine claw. The palp is about as stout as the legs.

3. *Specimen In. 29132-B* in the A. Théry collection of the British Museum, in a large piece of amber with a number of different insects and two mites. Total size 1.32 mm.

## Second Branch DIONYCHAE

Family *Zoropsidae*

This interesting small family of cribellated spiders contains only five recent genera with a peculiar geographical distribution. The Genus *Zoropsis* is typical of the Mediterranean region and is also represented in the Canary Islands. The Genus *Raecius* is found in Abyssinia. The Genera *Uduba* and *Zorodictyna* seem to be restricted to Madagascar. The Genus *Zorocrates* is represented by seven species distributed from Panama northward to Texas and Arizona. To these genera now is added the new fossil Genus *Adamator* from the Baltic amber. There is no question of its familial affiliation and it is quite certain that it is different from the recent genera. It seems to be nearest related to the American Genus *Zorocrates* from which it may be distinguished by the eye-group and by the loss of all retroventral tibial spines representing an advanced rather than an ancestral condition.

Genus *Adamator*, nov.

Carapace low, with a broad head transversely truncated and on the same level with the thorax. Thoracic groove longitudinal. Lateral edges of carapace folded under and supplied with four thorns each facing the corresponding coxal foramen. Eight eyes in two very slightly recurved rows. Posterior row much longer than anterior row. Quadrangle trapeze shaped, wider behind than in front and wider than long. Lateral eyes far apart. Clypeus low. Chelicerae strongly geniculated, with oblique margins. Maxillae parallel. Lip rectangular, longer than wide. Sternum flat, oval, longer than wide. First coxae wide apart. Legs in order 4213. First tibia with a proventral row of four spines. First and second metatarsi and tarsi scopulate, third and fourth without scopulae. Fourth metatarsus with a calamistrum extending from base to middle and formed by a single row of curved hairs. Two claws, similar, toothed. Claw-tufts present only on first and second tarsus and formed by an extension of the scopula. Trichobothria numerous, increasing in length distally. Abdomen flattened above. Six spinnerets. Anterior pair cone-shaped, stout. Posterior pair cylindrical, slender, longer than anterior pair. A narrow cribellum present. Palp with a claw. Type *A. succineus*.

(Derivation of name: Latin—adamator—a lover.)

*Adamator succineus*, n. sp. Plate LXIV, Fig. 581, Plate XXI, Figs. 195 to 201, Plate XXV, Fig. 231.

British Museum, Collection Klebs 486, No. 13404, In. 18729.

A single specimen, rather poorly preserved. The amber is full of air-bubbles, but most of the structures can be seen well. Color of chitin light rufous. Chelicerae darker, abdomen lighter.

Type. Mature female. The second largest spider in the collection. Total length with chelicerae 9.6 mm. Carapace flat, 3.3 mm. long, 2.8 mm. wide between second and third coxae where it is widest. Head with parallel sides, 1.9 mm. wide, practically on a level with the thorax although clearly separated from it by shallow sulci. Anteriorly the head is transversely truncated. The thoracic groove is deep, longitudinal.

Eight eyes in two rows, both rows very slightly recurved. The anterior row 1.12 mm. long, the posterior row 1.60 mm. long, *i. e.* much longer than the anterior row, but yet considerably shorter than the width of the head. Ratio of eyes AME:ALE:PME:PLE = 8:8:7.5:8. The PME are flat. The AME are slightly separated from each other (Fig. 199). Between them and the ALE is a fairly deep cleft. The PME are separated from each other by about one and one-half of their diameter. The lateral eyes are wide apart. The quadrangle is wider behind than in front in ratio 27:21, wider than long in ratio 27:18. The clypeus is less than the diameter of the AME.

The lateral edges of the carapace are folded under (Fig. 196) and supplied with four thorns each, each thorn opposite the corresponding coxal foramen. Owing to the transparency of the chitin this may be clearly seen through its wall. The carapace is clothed with recumbent, short hair and with few, scattered bristles. Four long bristles are present on the clypeus in front of the median eyes and several bristles on the sides of the head.

The chelicerae are short, stout and strongly geniculated. The basal joint is 1.4 mm. long. A distinct boss is present. Outer edges of chelicerae parallel, inner edges divergent. Margins oblique, their armature concealed by emulsion. Anterior surface of chelicerae clothed with long, curved bristles. Fangs powerful, fairly long, curved.

The lip (Fig. 195) is rectangular, longer than wide, in ratio 16:13, transversely truncated in front, with lateral excavations in basal third. Maxillae long, parallel, considerably wider in front

than at base. Palp originating near base. Inner edge of maxillae concave. The sternum is flat, oval, longer than wide in ratio 22:15. Its anterior truncature is as wide as the lip. The sternum is sparsely clothed with short hair and a tuft of hair is present at the posterior end. The first coxae are wide apart, but not as wide as the second coxae. The fourth coxae are separated by half their width.

Leg formula	4	2	1	3
	3.5	3.0	2.9	2.7

	Femur	Pat. + Tib.	Metat.	Tarsus	Total
I	2.85	3.60	1.90	1.14	9.49
II	3.13	3.70	2.00	1.23	10.06
III	2.66	3.23	2.00	1.04	8.93
IV	3.27	3.80	3.04	1.42	11.53

The width of the patellae cannot be measured and therefore no tibial index can be given.

*Spines.* First leg. Femur dorsal 1-1-1, prolateral 1-1-1, retrolateral 1-1-1, ventral 0. Patella dorsal 1-1 bristles, elsewhere 0. Tibia dorsal 1 apical bristle, ventral 1p-1p-1p-1p, elsewhere 0. Metatarsus ventral 2-0, elsewhere 0. Second leg same as first except femur dorsal 1-1-0, prolateral 1-0-0, retrolateral 0. Tibia ventral 0-0-1p-0. Third leg. Femur dorsal 1-1-0, prolateral 1-0-0, elsewhere 0. Patella dorsal 1-1 bristles, elsewhere 0. Tibia ventral 1p-1p, elsewhere 0. Metatarsus ventral 2-0, elsewhere 0. Fourth leg. Femur dorsal 1-1-0, retrolateral 0-1-1, elsewhere 0. Patella dorsal 1-1 bristles, elsewhere 0. Tibia dorsal 1 apical bristle, prolateral 1-1, retrolateral 0, ventral 2-2-2. Metatarsus retrolateral 1-1-0, elsewhere 0.

First and second tarsi scopulate to base, first and second metatarsi scopulate in distal three-quarters. The scopulae are composed of flat, lanceolate hairs. Third and fourth metatarsi and tarsi without scopulae. Their ventral hair is of the simple kind. The dorsal metatarsal end membrane is well visible (Fig. 201). Claw tufts are present only on the first and second leg and are formed not by tenent hairs, but by an extension of the tarsal scopula under the claws. For this reason claw tufts are wanting on the third and fourth leg because these legs lack scopulae also. Trichobothria numerous, in two rows on tibiae, and metatarsi, in several rows on tarsi, increasing in length distally on all joints.

Two claws, similar, stout, curved, with four large teeth (Fig 197). Serrated bristles wanting. The fourth metatarsus with a calamistrum (Fig. 231) composed of a single row of curved hairs and extending from a point near the base to its middle. The calamistrum is difficult to see, but is unmistakable when the spider is placed in a certain position.

The abdomen is flattened above, 5.5 mm. long, 2.8 mm. wide in middle, clothed with recumbent hair interspersed with some fine bristles. The anal tubercle is prominent, cone-shaped, distinctly two-jointed. Its diameter at base is 0.43 mm., its height 0.28 mm. Six spinnerets and a cribellum (Fig. 200). Anterior spinnerets cone-shaped, subcontiguous. Posterior spinnerets cylindrical, more slender and longer than the anterior ones. Their terminal joint is short. At base they are separated by the width of the anal tubercle. The median spinnerets are also cylindrical, subcontiguous and much shorter than the posterior ones. Under high power one can see on all spinnerets simple spinning tubes, about five on each posterior spinneret may be counted. Spigots seem to be wanting on all spinnerets. In front of the spinnerets and occupying the entire width of the spinning group the narrow cribellum is visible. It seems to be divided in the middle, but the division line is rather indefinite.

The palp is rather stout and has several long bristles. The terminal joint is as long as the femur and has a slender, curved claw with three teeth. There is an indication of an epigynum on the abdomen, but no structure can be discerned.

#### Family *Inceptoridae*, nov.

This new family includes a single genus and species represented by a single immature specimen. The characters of the new species are not unique in themselves. By disregarding some of them one could place it in one of several different families. For a while I thought of including it in the new Family *Insecutoridae* with which the spider under consideration has much in common. But the *Insecutoridae* have three claws, while the spider for which the Family *Inceptoridae* is being proposed has only two claws. It is true that *Inceptor* is also wanting claw-tufts, a condition which suggests that the third claw has been lost independently of other characters. Such loss is not unknown. We find a similar condition in *Sicariidae* and *Zodariidae*. If all the other important char-



acters were present, the inclusion of a two-clawed species in an otherwise three-clawed family would be not only justified, but imperative. But there are important differences in the characters of the carapace, eyegroup, maxillae, legs and spinnerets which make the inclusion impossible. At least provisionally the new family must stand.

Carapace low, with head on the same level and a longitudinal thoracic groove very far from anterior end. Eight eyes in two rows. Chelicerae with boss and transverse margins which are smooth. Lip free. Maxillae parallel. Sternum convex, broadly oval. None of the trochanters notched. Legs fairly stout, spinose. Two claws. similar. Claw-tufts, scopulae and serrated bristles wanting. Trichobothria long and fairly numerous. Female palp with a claw. Six spinnerets. Anterior pair slightly stouter and longer than posterior pair. Colulus wanting.

Genus *Inceptor*, nov.

With the characters of the family. Head wider than eyegroup. Posterior median eyes half as large as the AME. Order of legs 4123. Spines more or less erect. Claws with a row of six or seven teeth. Abdomen ellipsoidal. Type *I. aculeatus*.

(Derivation of name: Latin—inceptor—a beginner.)

*Inceptor aculeatus*, n. sp. Plate LXIX, Fig. 625, Plate LIV, Figs. 504 to 509.

A single, immature specimen in the Crosby collection of Cornell University, No. 5. The specimen is well preserved in clear amber except for a thin layer of white emulsion around the mouthparts and abdomen. The color of the chitin is light rufous, abdomen greyish yellow.

Type. Total length 2.3 mm. Carapace (Fig. 505) 0.96 mm. long, 0.77 mm. wide between second and third coxae where it is widest, 0.38 mm. in the region of the eyegroup. Thoracic groove longitudinal, line-like, placed on the posterior declivity which is short and steep. The carapace is low, almost level. The eyegroup is 0.29 mm. wide, *i. e.* considerably narrower than the width of the head. The anterior row is so slightly recurved that it is almost straight. The posterior row is slightly procurved and longer. Viewed from in front (Fig. 507) the anterior row is slightly down-curved. Ratio of eyes AME:ALE:PME:PLE = 2:2:1:2.

The eyes of the anterior row are contiguous. The PME are farther apart than they are from the PLE. The quadrangle is wider behind than in front, wider than long. The clypeus is equal to the diameter of the AME.

The chelicerae (Fig. 507) are parallel, rather stout, with boss and transverse margins. There are a few hairs on the margins, but no teeth. The fangs are broken near their end. If one reconstructs their shape by continuing the curved line of the proximal portion as it appears under microscope, one has to come to the conclusion that the fangs were short, only very slightly curved and rather quickly ending in a point. The maxillae are slightly converging, elongated, with the palp originating near the base. The lip is trapeze-shaped, somewhat wider than long and barely reaches the middle of the maxillae (Fig. 506). The sternum is distinctly convex, sparsely clothed with brown hair. It is oval, longer than wide in ratio 25:22. The first coxae are wide apart. The fourth coxae are separated by their width.

Leg formula	<sup>1</sup> 3.0	<sup>1</sup> 2.5	<sup>2</sup> 2.2	<sup>2</sup> - 2.2
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	Femur	Pat. + Tib.	Metat.	Tarsus	Total
I	0.72	0.84	0.41	0.41	2.38
II	0.62	0.68	0.38	0.43	2.11
III	0.60	0.62	0.48	0.41	2.11
IV	0.84	0.90	0.58	0.53	2.85

Width of first patella 0.120 mm. First tibial index 14.

Width of fourth patella 0.120 mm. Fourth tibial index 13.

The legs, especially the fourth pair, are spinose. The spines are long and more or less erect.

First leg. Femur dorsal 1-1-1, elsewhere 0. Patella 0. Tibia dorsal 1-1-1, ventral 2-2, elsewhere 0. Metatarsus ventral 2-2, elsewhere 0.

Second leg same as first, except tibia ventral 1r-0, metatarsus ventral 1r-1r.

Third leg. Femur dorsal 1-1-1, prolateral 0-0-1, elsewhere 0. Patella dorsal 1-1 bristles, elsewhere 0. Tibia dorsal 1-1, prolateral 1-1, retrolateral 1-1, ventral 1r-0. Metatarsus dorsal 1-1 small bristles, ventral 1r-1r, elsewhere 0.

Fourth leg. Femur 1-1-1, elsewhere 0. Patella dorsal 1-1

bristles, elsewhere 0. Tibia dorsal 1-1-1, the apical spine very small, prolateral 1-1, retrolateral 1-0, ventral 1r-0. Metatarsus dorsal 2-2, prolateral 1-1, retrolateral 1-1, ventral 1r-0.

Legs sparsely clothed with simple hair. Trichobothria very long. There are two on the tibia, two on the metatarsus and three on the tarsus. Two claws, similar, with six or seven long teeth (Fig. 509). Although a third claw is wanting, claw-tufts are also wanting, as well as serrated bristles. Neither are scopulae present on any of the legs. The palpi are of the female type, with a claw.

The abdomen is ellipsoidal, 1.2 mm. long, 0.7 mm. wide, clothed with long, light brown hair. Six spinnerets. Anterior pair is slightly longer than posterior pair, contiguous at base. All spinnerets are cylindrical, with the median pair much smaller and barely visible. The anal tubercle is large, distinctly two-jointed, cone-shaped. A colulus is wanting.

#### Family *Eusparassidae* (= *Sparassidae*)

This family is represented in the Baltic amber by two subfamilies, *Eusparassinae* and *Sparianthidinae*. To the former belong three new genera, *Collacteus*, *Caduceator* and *Adulatrix*, related to, but distinct from the recent Genera *Zachria* and *Delena*. The Subfamily *Sparianthidinae* is represented by a single new Genus *Eostasina* which as the name implies is related to, but distinct from the recent Genus *Stasina*. *Zachria* and *Delena* are found in New Guinea and Madagascar. *Stasina* has a much wider distribution including tropical Asia, Africa and America. In Europe the Family *Eusparassidae* is represented at present by the Genera *Olios*, *Eusparassus* and *Micrommata*, comprising six species.

#### Subfamily *Eusparassinae*

The fossil genera belonging to this subfamily may be separated from their recent relatives by the following characters:

1. Carapace about as long as wide. Anterior median eyes largest. Recent ..... *Delena*.
- \* Carapace longer than wide in ratio 9:8 or 9:7. Anterior median eyes equal to or smaller than the laterals ..... 2
2. Order of legs 2143. All metatarsi and tarsi scopulate. Recent ..... *Zachria*.
- \* Not so ..... 3

3. Order of legs 4231. Only first and second tarsi and metatarsi scopulate. Sternum oval, truncated at both ends. Lateral eyes separated by not quite two diameters . . . . .  
*Collacteus.*
- \* Order of legs 4213 . . . . . 4
4. First and second tarsi and metatarsi scopulate. Legs with spines . . . . . *Adulatrix.*
- \* None of the tarsi and metatarsi scopulate. Legs without spines . . . . . *Caduceator.*

Genus *Collacteus*, nov.

Carapace flat, longer than wide, truncated in front. Eyes in two rows, posterior row much longer than anterior row. Posterior median eyes smallest. Quadrangle wider behind than in front, wider than long. Lateral eyes separated by more than their diameter. Chelicerae strongly geniculated, with boss and oblique margins. Promargin smooth, with a scopula. Retromargin without scopula, but armed with three teeth. Maxillae parallel. Lip wider than long. Sternum oval, truncated at both ends. First coxae far apart. Legs laterigrade, in order 4231, with true spines. First and second tarsi and metatarsi scopulate to base. Third and fourth tarsi and metatarsi without scopulae. Two claws, similar, with teeth. Claw-tufts well developed. Trichobothria numerous. Six spinnerets, cylindrical, anterior pair contiguous, posterior pair wide apart. Colulus wanting. Type *C. captivus*.

(Derivation of name: Latin—collacteus—a foster-brother.)

*Collacteus captivus*, n. sp. Plate LXIV, Fig. 579, Plate XVI, Figs. 148 to 154, Plate XXI, Figs. 202, 203.

British Museum, In. 18714, Collection Klebs 472, No. 13414.

A single specimen in the same piece of amber with a male *Orchestina baltica*. The color of the chitin reddish-yellow, legs somewhat paler.

Type. Female. Total length with chelicerae 6.65 mm. Carapace 2.7 mm. long, 2.2 mm. wide between second and third legs where it is widest, 1.38 mm. wide in front where it is transversely truncated. The carapace is very flat and the eyegroup is somewhat narrower than the head. Eight eyes in two rows (Fig. 148), both slightly recurved. First row 0.77 mm. wide, second row 1.22 mm.

Ratio of eyes AME: ALE: PME: PLE = 6:6:5:6. AME separated by their diameter. PME separated by two of their diameters. Quadrangle wider behind than in front in ratio 18:16, wider than long in ratio 18:13. Eyes of first row equidistant. Lateral eyes separated by 10/6 of their diameter. PLE are elevated on distinct tubercles and are directed backward and outward. PME are oval and flat. The clypeus is equal only to the radius of the AME. There are neither bristles nor hair on the carapace. The thoracic groove is longitudinal and is situated far back.

The chelicerae (Fig. 150) are stout, strongly geniculated, with a distinct boss and oblique margins. The basal joint is 1.1 mm. long, 0.6 mm. wide at base. The promargin (Fig. 152) is smooth, with a well developed scopula. The retromargin has no scopula, but is armed with three strong teeth. The fang is rather short and evenly curved. The maxillae (Fig. 153) are rhomboidal. Consequently, their base and their end are farther apart than their middle. The outer distal angle is rounded and provided with a serrula. The inner diverging edges are supplied with well developed scopulae. The lower surface of the maxillae is convex. The palp arises about half way between the base and the apex. The lip is free, distinctly emarginate at the end, with lateral excavations at the base. It is wider than long in ratio 17:15, narrower in front than at the base and distinctly convex. The sternum (Fig. 202) is neatly oval, slightly convex, longer than wide in ratio 4:3, truncated at both ends to about the same width. It is sparsely clothed with long hair. The first coxae are wide apart. The fourth coxae are separated by slightly more than half their width. They are longer than the other coxae.

The legs are laterigrade.

$$\text{Leg formula } \frac{4}{3.4} \quad \frac{2}{3.0} \quad \frac{3}{2.9} \quad \frac{1}{2.9}$$

The left third leg was autotomized in life and is missing. The right third leg is broken at the knee-joint and the patella is missing.

	Femur	Pat. + Tib.	Metat.	Tarsus	Total
I	2.28	3.04	1.61	0.90	7.83
II	2.56	3.13	1.61	0.90	8.20
III	2.37	2.37	2.37	0.85	7.96
IV	2.66	3.32	2.37	0.90	9.25

*Spines.* First leg. Femur dorsal 0-1-1, prolateral 1-1-0, retrolateral 0-1-0, ventral 0. Patella dorsal 0-1 bristle, elsewhere 0. Tibia dorsal 0-1, ventral 0-1p-0, elsewhere 0. Metatarsus ventral 2-2, elsewhere 0.

Second leg same as first.

Third leg. Femur dorsal 1-1-1, elsewhere 0. Patella ?, Tibia ventral 2-2-2, elsewhere 0. Metatarsus ventral 2-2, elsewhere 0.

Fourth leg. Femur dorsal 0-1-1, elsewhere 0. Patella dorsal 0-1 bristle, elsewhere 0. Tibial retrolateral 1-1-1, ventral 1p-1p-1p, elsewhere 0. Metatarsus retrolateral 1-1, ventral 2-2-2, elsewhere 0.

First and second metatarsi and tarsi scopulate to base. Third and fourth metatarsi and tarsi without scopula. Two claws, similar, curved, with four teeth (Fig. 151). Claw-tufts well developed. Trichobothria numerous (Fig. 154), in a single row on tibiae, metatarsi and tarsi, increasing in length distally. On the metatarsi they are inclined forward, on the tarsi they are vertical, but curved backward at the end.

The palp is of the female type, spinose, with several trichobothria on the tibia. The terminal joint ends in a claw which is long and more slender than the tarsal claws, less bent and supplied with four teeth. The basal tooth is so small that it can be easily overlooked.

The abdomen is elongated and slightly depressed above. It is 3.5 mm. long, 1.8 mm. wide, more or less pointed behind, sparsely clothed with fairly long hair which becomes more numerous on the sides. The anal tubercle is cone-shaped, prominent. The spinnerets (Fig. 203) are cylindrical. The anterior pair are contiguous, stout, of the same length as the posterior pair which are wide apart. The median pair is shorter. A colulus is wanting. The ventral surface of the abdomen is partly caved in, partly coated with white emulsion. Under the circumstances no epigynum can be seen and it is impossible to decide whether it is a mature or an immature female.

All hair is of the simple kind.

#### Genus *Caduceator*, nov.

Carapace flat, longer than wide, little narrowed in front. Eye-group somewhat less wide than the head. Eyes in two rows, both recurved. Quadrangle trapeze-shaped, wider behind than in front, wider than long. Lateral eyes separated by about two diameters. Thoracic groove longitudinal, far back. Chelicerae geniculated. Maxillae slightly inclined over lip. Sternum oval, truncated at

both ends. First coxae wide apart. Legs laterigrade, in order 4213, without spines and without scopulae. Female palp with claw. Tarsal claws two, similar. Six spinnerets. Anterior pair cone-shaped, stout, contiguous at base. Posterior pair cylindrical, longer than anterior pair. Colulus wanting. Type *C. minutus*.

(Derivation of name: Latin—Caduceator—herald.)

*Caduceator minutus*, n. sp. Plate LXIX, Fig. 619, Plate LV, Figs. 510 to 515.

A single specimen in the collection of the Peabody Museum, Yale University, from the Lower Oligocene of Polangen, Germany, No. 3602-(3). Collected by H. M. Magil. It is a small, well preserved specimen of indefinite age and sex. There are air-bubbles under the abdomen on the mouthparts and various other places. In the same piece of amber there is an object which looks like an oval egg-cocoon, but it seems doubtful that it belongs to the above spider, both because of its large size and because the spider is apparently immature.

Type. Pullus. Total length 1.9 mm. Carapace (Fig. 512) 0.89 mm. long, 0.77 mm. wide between second and third coxae where it is widest, 0.50 mm. wide in front. The carapace is flat. The cephalic margins are parallel, the cephalothoracic sulci converge in front of the longitudinal thoracic groove which is situated about one-third from the posterior edge of the carapace. The eyegroup is 0.46 mm. wide, *i. e.* somewhat narrower than the width of the head. Eight eyes in two rows, both slightly recurved. The entire eyegroup occupies a low elevation. Ratio of eyes AME: ALE:PME:PLE = 1.25:2:2:3. The AME are separated by  $4/1.25$  of their diameter, and from the ALE by half that distance. The PME are separated from each other by four diameters of the AME or two and a half of their own diameter, and from the PLE by their diameter. The lateral eyes are separated from each other by two diameters of the ALE. The quadrangle is wider behind than in front and wider than long. The clypeus is equal to about the diameter of the AME.

The chelicerae are stout, short, distinctly geniculated. The fangs seem to be slender and rather long, but details cannot be seen on account of air-bubbles. Maxillae (Fig. 510) are slightly inclined over the lip. The palp is inserted at the base, its trochanter occupies half the length of the maxilla. The lip is free, trapezeshaped, slightly emarginate at the end. The sternum is oval,

truncated at both ends, slightly convex and about as long as wide. The first coxae are wide apart. The fourth coxae are separated by at least one and one-half of their width. The legs are laterigrade, devoid of spines and of scopulae, except for a curved bristle at the end of the third and fourth femora and the usual dorsal bristles on patella 1-1, and on tibia 1-1. The metatarsus ends in a dorsal membrane clearly visible on the left fourth leg (Fig. 514).

Leg formula	4	2	1	3
	2.7	2.3	2.3	1.8

	Femur	Pat. + Tib.	Metat.	Tarsus	Total
I	0.62	0.74	0.38	0.31	2.05
II	0.70	0.70	0.38	0.31	2.09
III	0.48	0.50	0.36	0.24	1.58
IV	0.67	0.86	0.50	0.36	2.39

Width of first patella 0.120 mm. First tibial index 14.

Width of fourth patella 0.130 mm. Fourth tibial index 17.6.

Claw-tufts wanting. Two claws, similar (Fig. 515), curved, with four teeth increasing in length distally. Trichobothria long, but not well visible. Palpi of the female type, with terminal claw (Fig. 513) of the same type as the tarsal claws, but with only three teeth.

Abdomen rather flat, truncated in front, 0.91 mm. long, 0.65 mm. wide. There are clearly visible lines present in the posterior third of the abdomen, possibly representing segmentation. Six spinnerets. Anterior pair stout (Fig. 511), cone-shaped, contiguous or very nearly so, with short, rounded terminal joint supplied with two spigots. Posterior spinnerets cylindrical, more slender and longer than anterior pair. Their terminal joint almost cylindrical, but shorter than basal joint and supplied with four or five simple spinning tubes with long end. Median spinnerets not well visible, but one can see at the end of the right one a single simple spinning tube.

#### Genus *Adulatrix*, nov.

Carapace flat, longer than wide, little narrowed in front. Margins of head parallel. Thoracic groove longitudinal. Eight eyes in two slightly recurved rows. Posterior row much wider than anterior row. AME larger than PME and closer together. Quadrangle wider behind than in front and wider than long. Lateral eyes wide apart. Clypeus low. Chelicerae stout, geniculated, with boss and oblique margins. Promargin smooth, with a scopula.



Retromargin with a scanty scopula and three teeth. Maxillae parallel. Lip free, rectangular. Sternum longer than wide, pointed behind. First coxae far apart. Legs laterigrade, in order 4213. First and second tarsi and metatarsi with scopulae, third and fourth without scopulae. Spines present. Claw-tufts well developed. Two claws, similar, with teeth. Trichobothria numerous, in two rows on tibiae, metatarsi and tarsi increasing in length distally on every joint. Female palp with claw. Abdomen flattened, with six cylindrical spinnerets. Type *A. fusca*.

(Derivation of name: Latin—*adulatrix*—a female flatterer.)

#### Key to Species

1. Tarsal and metatarsal scopulae well developed ..... 2
- \* Tarsal and metatarsal scopulae scanty ..... 3
2. Carapace under 4 mm. in length. First leg at least 3.3 times longer than carapace. Recumbent hair on the back of the abdomen evenly distributed ..... *A. fusca*.
- \* Carapace over 4 mm. in length. First leg only 3 times as long as carapace. Recumbent hair on back of abdomen wanting in four places, leaving two pairs of bare, oval spaces ..... *A. decumana*.
3. Carapace 1.9 mm. long or longer. First leg 3.6 times longer than carapace. Anterior median eyes as large as, or slightly larger than posterior median eyes .....  
*A. rufa*.
- \* Carapace 1.2 mm. long. First leg 3.1 times longer than carapace. Anterior median eyes slightly smaller than posterior median eyes ..... *A. parva*.

*Adulatrix fusca*, n. sp. Plate LXII, Fig. 571, Plate LXIII, Fig. 573, Plate XXII, Figs. 204 to 211.

Two specimens in the collection of the British Museum.

- 1) Type, In. 18734, Klebs 491, No. 13+12. Figs. 204 to 207 and 571.
- 2) Paratype, In. 18726, Klebs 483, No. 13406. Figs. 208 to 211 and 573.

*Type.* Immature female. A well preserved specimen in amber which is clear on the dorsal surface of the spider, but presents various imperfections on the ventral surface, obstructing a clear view of the mouthparts and abdomen. The color of the chitin is dark brown except for the abdomen which is light rufous.

Total length including chelicerae 5.7 mm. Carapace 2.5 mm. long, 2.1 mm. wide between second and third coxae where it is widest, 1.36 mm. wide in the region of the eyes. Head (Fig. 204) with parallel sides, truncated in front. The carapace is flat with a deep longitudinal groove and gradually sloping posterior declivity. The posterior margin is straight. The surface is clothed with fine, recumbent hair. Bristles are present only on the sides of the eyegroup and on the clypeus. The head slopes down gradually anteriorly, so that the edge of the clypeus is visible from above. The cephalothoracic sulci disappear before they reach the middle of the carapace. The eyegroup is narrower than the head, being only 1.04 mm. wide.

Eight eyes in two slightly recurved rows, the first row much shorter than the second, being only 0.79 mm. wide. The PME are flat. Ratio of eyes AME:ALE:PME:PLE = 6.5:8:7:8. AME separated from each other by 3.5/6.5 of their diameter and from the ALE by half their radius. PME separated from each other by 5/6.5 of the diameter of AME and from the PLE by twice that distance. The lateral eyes are separated from each other by more than their diameter. The clypeus is equal to less than the radius of the AME (2/6.5).

The chelicerae (Fig. 205) are stout, geniculated, with well developed boss. Basal joint 1.1 mm. long, 0.5 mm. wide. The outer edges of the chelicerae are parallel, but the inner ones are diverging. The margins are oblique. The promargin is smooth, with a scopula. The retromargin is not visible. The fang is short, evenly curved. Maxillae and lip poorly visible. The sternum is longer than wide, pointed between the hind coxae which are separated by somewhat less than their width. First coxae wide apart. None of the trochanters are notched. Legs laterigrade.

Leg formula	4	2	1	3	
	3.5	2.9	2.9	2.7	
	Femur	Pat. + Tib.	Metat.	Tarsus	Total
I	2.20	2.80	1.32	0.88	7.20
II	2.20	2.80	1.36	0.88	7.24
III	1.92	2.40	1.48	0.84	6.64
IV	2.60	3.04	2.16	0.96	8.76

Width of first patella 0.384 mm. First tibial index 14.

Width of fourth patella 0.360 mm. Fourth tibial index 12.

First and second tarsi heavily scopulate to base, first and second metatarsi scopulate in distal three-quarters. Third and fourth tarsi and metatarsi without scopulae.

Spines few, but stout. First leg. Femur dorsal 1-1-1, prolateral 1-1-1, elsewhere 0. Patella dorsal 1 apical bristle, elsewhere 0. Tibia ventral 1p-1p-0, elsewhere 0. Metatarsus ventral 2-0, elsewhere 0.

Second leg same as first except femur prolateral 0.

Third leg. Femur dorsal 0-1-0, prolateral 1-0-0, elsewhere 0. Patella dorsal 1 apical bristle, elsewhere 0. Tibia ventral 1p-1p-2, elsewhere 0. Metatarsus ventral 2-0, elsewhere 0.

Fourth leg same as third except tibia ventral 1p-1p-1p, retrolateral 1-1. Metatarsus retrolateral 1-1. The third right leg was autotomized in life when the spider was caught in the gum. Probably due to the attempt of the spider to free itself that leg became displaced so that its trochanter in the amber lies behind the fourth coxa. Unlike the other legs it lost its color.

Two claws, similar, powerful, evenly curved, with four stout teeth. Claw-tufts well developed. Trichobothria numerous, long, in two rows on tibiae, metatarsi and tarsi, increasing in length distally on each joint. The legs are clothed with at least three kinds of hair. There is white, short, fine, recumbent hair. Less abundant is brown hair which is considerably longer and stouter than the white hair. Finally there is still less abundant and still longer erect hair having setose appearance and especially noticeable on the second metatarsi. The ventral surface of the third and fourth metatarsi is clothed only with the third type of hair. The third and fourth tarsi have on their ventral surface much shorter, but still setose hair. The scopulae on the first and second tarsi and metatarsi are formed by short, flattened hair (Fig. 207). This hair is sculptured and comparatively short.

The abdomen (Fig. 206) is flattened above, truncated in front, 2.8 mm. long, 1.95 mm. wide. It is clothed with white, recumbent hair and dark bristles. Its ventral surface is clothed with short, brown setae as may be gathered from an examination of a few places which are less coated with emulsion. An epigynum is not visible, although the genital fold can be seen and shows at its anterior edge in the middle a dark brown structure which must be interpreted as a developmental stage of an epigynum. The spinnerets may be seen through the emulsion in a beam of bright light. They

are cylindrical. No detail can be seen. The palp is stout, but of the female type. The femur has one dorsal spine in middle. The patella has a long, dorsal, apical bristle. The tibia has 1-1 prolateral and 1-1 retrolateral stout bristles. Several stout bristles are present on the terminal joint. The structure of the claw cannot be seen on account of dirt.

*Paratype.* Mature female. Slightly larger than the type, but of the same color and appearance. Abdomen coated with white emulsion, but mouthparts well visible. Total length including chelicerae 8.3 mm. Carapace 3.88 mm. long, 3.20 mm. wide between second and third coxae where it is widest, 2.20 mm. wide in the region of the eyes. Width of eyegroup 1.88 mm. The carapace is flat, with a gently sloping posterior declivity, deep longitudinal thoracic groove and convex sides. The head is only very little higher than the thorax and its free lateral margins are parallel, while the cephalothoracic sulci disappear gradually before reaching the middle of the carapace. The carapace is clothed with recumbent, short, white hair directed forward and inward, and with long, brown bristles on the sides of the eyegroup and on the clypeus.

Eight eyes in two recurved rows (Fig. 210). The first row is much shorter than the second row and considerably less recurved. The presence of extraneous silvery matter on the head between the lateral eyes gives the impression that the lateral eyes are on a common, low elevation. This may be so, but the elevation of this portion of the head over the rest must be, indeed, very slight. The PME are flat. There is a deep cleft between the AME and ALE, filled out with a silvery film. Exact measurement of eyes is scarcely practicable, but it seems to be certain that the PME are smaller than the AME. The distance between the AME is about equal to their radius, while the distance between the PME is almost three times as great. The PLE are equally distant from the ALE and the PME. The quadrangle is wider behind than in front in ratio 32:25, wider than long in ratio 32:22. The width of the first row is 1.36 mm., that of the second row 1.96 mm. The clypeus is very low.

The chelicerae (Fig. 208) are powerful, short, geniculated, with strong boss. Basal joint 1.6 mm. long, 1.0 mm. wide. The margins are oblique. The promargin has a thick, long scopula of light

brown bristles, but no teeth. The retromargin has a very scanty scopula and is armed with three stout, conical teeth. The fang is evenly curved, only 1.0 mm. long if measured in a straight line from base to tip. Under the fang one can see a small accessory sclerite. The maxillae are parallel. The palp originates at the base where a small projection serves to receive the trochanter.

The outer edge of the maxilla is supplied with two or three rows of stout, curved bristles. The anterior end is occupied by a thick, rufous scopula with a distinct tuft of long bristles near the outer angle. The free, lower surface of the maxilla is clothed with a few hairs and is evenly convex. The lip is distinctly longer than wide, reaching beyond the middle of the maxillae. There are stout bristles at its end and hair on its surface. The sternum (Fig. 209) is flat, oval, distinctly narrower in front than in the middle, pointed between the hind coxae which are separated by half their width. It is longer than wide in ratio 11:8. Anteriorly the sternum is narrowed down to the width of the lip. The surface is clothed with bristles directed toward the center, so that the bristles of the anterior half of the sternum face with their points backward and inward, while those of the posterior half forward and inward. Although the sternum is no wider than the lip in front, the first coxae are far apart. None of the trochanters are notched. The legs are laterigrade, in order 4213.

Leg formula	4	2	1	3
	3.3	3.0	2.9	2.6

	Femur	Pat. + Tib.	Metat.	Tarsus	Total
I	3.28	4.37	2.20	1.32	11.17
II	3.36	4.37	2.40	1.32	11.46
III	2.95	3.42	2.37	1.33	10.07
IV	3.60	4.37	3.42	1.52	12.91

Width of first patella 0.480 mm. First tibial index 11.

Width of fourth patella 0.480 mm. Fourth tibial index 11.

*Spines.* First leg. Femur dorsal 1-1-0, elsewhere 0. Patella dorsal 1-1 bristles, elsewhere 0. Tibia ventral 1p-1p-0, elsewhere 0. Metatarsus ventral 2-0, elsewhere 0.

Second leg same as first.

Third leg. Femur dorsal 1-1-0, prolateral 1-0-0, elsewhere 0. Patella dorsal 1-1 bristles, elsewhere 0. Tibia dorsal 1 apical

bristle, prolateral 0, retrolateral 1-1, ventral 2-2-2. Metatarsus prolateral 1-0, ventral 2-0, elsewhere 0.

Fourth leg same as third.

First and second tarsus thickly scopulate to base. First and second metatarsus scopulate in distal third. The scopula is composed of flattened, lanceolate hair (Fig. 207) with some sculpturing on its surface, which is resolved under high magnification into rows of minute dots. At regular intervals, sticking out beyond the scopula more or less erect hairs are present (Fig. 211). The third and fourth metatarsi and tarsi have no scopula. Here in place of a scopula is common, somewhat setose hair especially noticeable on the metatarsi. The claw-tufts are well developed, but are present only on the first and second leg because they are formed by a prolongation of the scopula under the claws. Two claws, similar, stout, curved, with four teeth. Trichobothria numerous, in two rows on tibiae, metatarsi and tarsi increasing in length distally on each joint. The metatarsi end in a dorsal, scoop-shaped membrane. The tarsi have a dorsal tubercle fitting into the metatarsal membrane.

The palpi are rather stout. The patella is almost as long as the tibia, the terminal joint is as long as the femur. There are stout, long bristles on the patella, tibia and terminal joint. Palpal claw less curved and much more slender than tarsal claws. It is toothed, but the number of teeth cannot be ascertained because of the position of the palp.

The abdomen is distinctly flattened above, 3.8 mm. long, 2.4 mm. wide, clothed with brown bristles visible through the emulsion. The ventral surface is so thickly coated with emulsion that nothing can be seen either of the epigynum or of the spinnerets. However, it seems certain from the appearance of the spider that it is a mature specimen.

*Adulatrix decumana* (Koch and Berendt). Plate LXIII, Fig. 575, Plate XXV, Figs. 229 and 230.

*Ocypete decumana* Koch and Berendt, 1854, p. 85, Pl. IX, Fig. 80.

Koch described three species under the Genus *Ocypete*, *O. crassipes*, *O. decumana* and *O. triguttata*. That genus has been synonymized by Simon with *Olios* and partly with *Heteropoda*. Menge expressed his doubt that *O. crassipes* belongs unqualifiedly to the Genus *Ocypete* with which it shares the disposition of the eyes,

because the relative proportions of the legs and the structure of the claws are more as in *Micrommata* and *Sparassus*. Of *Ocypete triguttata* Menge says that it is obviously a *Pythonissa*. The latter genus is a synonym of *Gnaphosa*, a spider belonging to a quite different family. The generic affiliation of *O. decumana* Menge does not seem to doubt. At least he left the species in the Genus *Ocypete* and mentioned two other species, *O. angustifrons* and *O. marginata* in his own collection. The two last named species are nomina nuda. This leaves only *O. decumana* for consideration. From the point of view of modern arachnology, as far as one can judge from the meager and general description given by Koch, *O. decumana* does not belong either to the Genus *Olios* or to the Genus *Heteropoda*. Nor can it be placed in any of the related recent genera. On the other hand it is certainly congeneric with *Adulatrix fusca*. It may be asked why I did not choose *Ocypete decumana* as genotype of the new Genus *Adulatrix*. The answer is simple. The choice of a genotype of a new genus is left to the discretion of the author. The specimen which I identified as *A. decumana* is neither as well preserved, nor as complete as the two specimens of *A. fusca*. The identification of the British Museum specimen of *A. decumana* with Koch's species was made by me on the strength of Koch's description. I have not seen his specimen. The description and figure being quite inadequate for the elimination of all possible doubt, misidentification remains possible. To avoid future confusion in such a case I decided to base the new genus on a new species.

Description of Hypotype. A single specimen, In. 18754, in the collection of the British Museum, coll. Klebs 512, No. 13402. It is the largest spider in the collection of the Museum and is in fairly transparent, but imperfect amber. The ventral surface is coated with white emulsion. Portions of the legs were polished off by the previous owner, so that the specimen is incomplete. Missing: left first metatarsus and tarsus, entire second left leg, left third tibia, metatarsus and tarsus, left fourth portion of metatarsus and tarsus. On the right side all legs are complete. Color of the chitin light rufous, legs somewhat darker, abdomen greyish yellow with darker hair.

Total length with chelicerae 9.8 mm. Carapace 4.1 mm. long, 3.3 mm. wide between second and third coxae where it is widest. Head 2.3 mm. wide, with parallel sides. Thoracic groove longi-

tudinal, deep. Posterior declivity short, fairly steep. Head on a level with thorax.

Eyegroup not as wide as head. Eight eyes in two rows, both rows gently recurved, the first row almost straight. For some reason the eyes are very difficult to see in any position and in any light. To all appearances the eyes are of about the same size except that the PME are possibly a little smaller. The eyes of the first row are barely separated from each other. The eyes of the second row are separated by about two diameters. The lateral eyes are about as far apart as the PLE are from the PME. The quadrangle is wider behind than in front and wider than long. The clypeus is low, with a transverse row of bristles. There are scattered bristles on the carapace which is otherwise clothed with short, recumbent hair.

The chelicerae are powerful, stout, strongly geniculated. Basal joint about 2.0 mm. long, 1.1 mm. wide. Anterior surface sparsely clothed with bristles. Fangs rather slender, gently curved, 1.1 mm. long in a direct line from base to tip. Lip longer than wide, with more or less parallel sides and a few bristles at the end. The maxillae are parallel. The palp is inserted in the middle of the outer edge. The lip reaches about to the middle of the maxillae. On the ventral surface of the maxillae a few dark bristles are present. The sternum is oval, longer than wide. The first coxae are wide apart. The fourth coxae are separated from each other, but the distance cannot be measured on account of a bubble obstructing the view. The legs are laterigrade.

Leg formula	4	2	1	3
	3.0	2.6	2.5	2.3

	Femur	Pat. + Tib.	Metat	Tarsus	Total
I	2.70	4.00	2.30	1.40	10.40
II	3.30	3.90	2.10	1.33	10.63
III	2.80	3.10	2.40	1.33	9.63
IV	3.30	4.10	3.30	1.42	12.12

*Spines.* First leg. Femur, only bristles dorsal 1-1-0, prolateral 1-1-1 in basal third, elsewhere 0. Patella dorsal 0-1 bristle, elsewhere 0. Tibia dorsal 1 apical bristle, ventral 1p-1p-0 spines, elsewhere 0. Metatarsus ventral 2-0, elsewhere 0.

Second leg same as first.

Third leg. Femur dorsal 1-1-0, elsewhere 0. Patella dorsal 1



apical bristle, elsewhere 0. Tibia retrolateral 1-1-1, ventral 2-2-2, elsewhere 0. Metatarsus retrolateral 1 before middle, ventral 2-0, elsewhere 0.

Fourth leg same as third, except metatarsus prolateral 1-1, retrolateral 1-1, ventral 2-2.

First and second tarsi scopulate to base, first and second metatarsi scopulate in distal two-thirds. Scopulae composed of flattened, lanceolate hairs. Third and fourth legs without scopulae. The hair on these legs is simple, only somewhat stouter on the metatarsi. Special serrated bristles (Fig. 230) are present under the claws. These bristles have barbules in their middle third. They are present on all tarsi. Two claws, similar, stout, evenly curved, with four teeth. Claw-tufts well developed on first and second tarsi, wanting on third and fourth, as they are formed by a prolongation of the scopula. The dorsal apical membrane is plainly visible on the left fourth metatarsus. The trichobothria are numerous, in two rows on tibiae, metatarsi and tarsi increasing in length distally on each joint.

The abdomen is flattened above, gradually becoming pointed behind, 5.0 mm. long, 2.9 mm. wide. It is thickly clothed with short, recumbent hair and with much less numerous, erect bristles. The hair forms a pattern inasmuch as it is wanting in four areas forming two pairs of ovals. The baldness of these ovals cannot be attributed to some accident because of their symmetry. The epigynum, if one is present, is quite concealed by the white emulsion and the spinnerets are barely visible. The palp has numerous stout bristles. The terminal joint ends in a claw which is rather slender, gently curved and supplied with three teeth.

*Adulatrix rufa* n. sp. Plate LXIII, Fig. 577. Plate LXII, Fig. 570. Plate XXIX, Figs. 267 to 272.

Two specimens in the collection of the British Museum.

- 1) In. 18731, coll. Klebs 488, No. 13440. Type.
- 2) In. 18759, coll. Klebs 517, No. 13413. Paratype.

A third specimen presumably of this species is the property of Dr. Helmuth DeTerra.

*Description of Type.* Immature female. The piece of amber contained a large air-bubble obstructing the view of the abdomen. A hole was made with a fine drill, the air sucked out and replaced

by cedar oil exposing to view the spinnerets. There are numerous planes of fission in the amber and white emulsion on the mouth-parts and on the back of the abdomen. The first pair of legs is torn off, not autotomized in the usual manner. The fracture is across the femur. This suggests that the spider in question did not possess the power to autotomize. This want of a faculty otherwise characteristic in spiders exists, as far as I know, only in *Hypochilus thorelli*, a representative of the oldest Suborder of cribellate Araneae. In all other true spiders, so far as known, only a quick cut with a sharp instrument can sever a leg in the manner in which it had been severed in *Adulatrix rufa*.

The color of the chitin is light rufous. The carapace is so transparent that the sternum is visible through it. The abdomen is almost colorless.

Total length with chelicerae 5.1 mm. Carapace (Fig. 267) 2.00 mm. long, 1.75 mm. wide between third coxae where it is widest. It is truncated in front and the free margins of the head are parallel. The head is 1.16 mm., the eyegroup 0.96 mm. wide, *i. e.* appreciably narrower than the head. The carapace is flat, with a line-like longitudinal thoracic groove set far back, with the head on the same level with the thorax and the posterior declivity very gently sloping. The cephalothoracic sulci disappear before they reach the middle. The surface of the carapace is clothed with short recumbent hair and with longer setose hair. Some long bristles are present on the head between and in front of the eyes.

Eight eyes in two gently recurved rows (Fig. 271). The first row is almost straight and only 0.67 mm. wide. Ratio of eyes AME:ALE:PME:PLE = 4.5:6:4.5:6. Quadrangle slightly wider behind than in front, wider than long in ratio 12:10. PME flat, oval. AME separated by one and one-half diameters and by less than their diameter from the ALE. The distance between the PME is considerably smaller than that between the PME and PLE, but exact measurements are not feasible. Lateral eyes are separated from each other by at least their diameter. The clypeus is almost wanting, being less than the radius of the AME.

The chelicerae (Fig. 268) are stout, short, strongly geniculated, with diverging inner edges. The basal joint is about 0.8 mm. long, covered in front with long, stout, brown bristles. Neither the margins, nor the fangs can be clearly seen. The maxillae (Fig. 270) are parallel. The lip reaches only to their middle and appar-

ently is longer than wide. The palp is inserted a little above the base of the maxilla. The sternum is oval, longer than wide in ratio 35:22, slightly narrowed in front, with a distinct prolongation between the hind coxae which are separated by their width. The sternum is flat, clothed with bristles. The first coxae are separated by somewhat less than the total width of the mouthparts. The fourth coxae are the largest. None of the trochanters are notched. Legs laterigrade, presumably in order 4213.

	Femur	Pat. + Tib.	Metat.	Tarsus	Total
I	?	?	?	?	?
II	1.76	2.40	1.20	0.80	6.16
III	1.60	2.00	1.20	0.72	5.52
IV	2.00	2.80	2.00	1.00	7.80

*Spines.* Second leg. Femur dorsal 1-1-0, prolateral 1-1-0, elsewhere 0. Patella dorsal 1 small apical bristle, elsewhere 0. Tibia ventral 1-1-0, elsewhere 0. Metatarsus ventral 2-0, elsewhere 0. Third leg. Femur dorsal 1-1-0, prolateral 1-0-0, elsewhere 0. Patella dorsal 1-1 small bristles, elsewhere 0. Tibia ventral 1-1-1, elsewhere 0. Metatarsus ventral 1p-0, elsewhere 0. Fourth leg same as third.

Second tarsus and metatarsus with a slight, but distinct scopula, on the former occupying the full length of the joint, on the metatarsus extending over the distal three-fifths. These scopulae are formed not by flat hairs, but apparently by common hairs standing at right angles to the leg. Neither the third, nor the fourth legs have any scopula. Claw-tufts are wanting on all legs, nor is there any indication that they were lost after death. Two claws, similar (Fig. 272), strongly, but evenly curved, with four teeth increasing in length distally. Trichobothria numerous and very long, in two rows on tibiae, in a single row on metatarsi and tarsi. The legs are clothed with soft, recumbent hair and with setose hair. The palpi are partly broken. A smooth palpal claw is present.

The abdomen is flattened above, slightly narrowed in front, somewhat pointed behind, 3.0 mm. long, 1.7 mm. wide. It is clothed with simple, recumbent hair and with fine bristles. The ventral surface is clothed with finer hair. Six spinnerets, cylindrical and fairly long. Anterior pair clearly separated (Fig. 269) by more than half their width, much stouter and longer than the posterior pair which is contiguous. The genital fold shows indica-

tions of a future epigynum, but the specimen is undoubtedly immature.

*Paratype*, In. 18759, Fig. 570. Immature female, slightly larger than the Type, well preserved in clear amber. The left fourth leg was polished off by the previous owner across the tibia. Cephalothorax and legs encrusted with tiny black crystals. Ventral surface coated with white emulsion. The color of the chitin wherever visible light yellow to rufous, but the carapace appears to be slate grey on account of the crystals.

Total length with chelicerae measured in a straight line 5.1 mm. Actual length probably a little greater because the abdomen is placed at an angle to the cephalothorax. Carapace 2.2 mm. long, 1.8 mm. wide, flat, with longitudinal thoracic groove and with head on the same level with thorax. The head is transversely truncated in front, with free margins parallel and total width 1.24 mm. Eyegroup 0.96 mm. wide. Eight eyes in two gently recurved rows. First row almost straight, 0.72 mm. wide. Ratio of eyes AME: ALE: PME: PLE = 4.5:6:4.5:6. PME flat, oval. Anterior eyes equidistant. Lateral eyes far apart. Quadrangle wider behind than in front, slightly wider than long. The eyes are difficult to see on account of the coating with crystals. The clypeus is very low, with some bristles.

The chelicerae are stout, with a strong boss, with diverging inner edges and strongly curved anterior surface which is clothed with long, rufous bristles. The margins are oblique, but their armature is not visible. However, a stout, yellow scopula is present. The fangs are evenly curved, fairly long. Lip and maxillae barely visible through the emulsion. The sternum is somewhat distorted, very convex, a little narrowed in front. The first coxae are far apart, the fourth coxae are separated by a little less than their width. The legs are laterigrade.

Leg formula	4	2	1	3
	3.6	3.0	3.0	2.8

	Femur	Pat. + Tib.	Metat.	Tarsus	Total
I	2.00	2.60	1.20	0.76	6.56
II	2.00	2.60	1.30	0.76	6.66
III	1.80	2.24	1.28	0.76	6.08
IV	2.20	2.80	2.00	0.96	7.96

*Spincs.* First leg. Femur dorsal 1-1-0, elsewhere 0. Patella dorsal 0-1 bristle, elsewhere 0. Tibia ventral 0-1-0, elsewhere 0. Metatarsus ventral 2-0, elsewhere 0.

Second leg same as first.

Third leg. Femur dorsal 1-1-0, prolateral 1-0-0, elsewhere 0. Patella dorsal 0-1 bristle, elsewhere 0. Tibia ventral 0-1-1, elsewhere 0. Metatarsus ventral 2-0, elsewhere 0.

Fourth leg. Femur dorsal 0-1-1, elsewhere 0. Patella dorsal 1-1 bristles, elsewhere 0. Tibia dorsal 0, prolateral 1-1, retrolateral 1-1, ventral 0-1-2. Metatarsus dorsal 0, prolateral 1-1, retrolateral 1-1, ventral 0-1r-1p.

First and second tarsi with a slight scopula occupying the full length of the joint. First and second metatarsi with a slight scopula occupying distal three-fifths. No scopulae on third and fourth legs. Claw-tufts wanting. Two claws, similar, curved, with four teeth. Trichobothria numerous, in two rows on tibiae, in one row on metatarsi and tarsi. Dorsal apical membrane at the end of the metatarsus visible on several legs. Palpal claw present, smooth. The abdomen is elongated, flattened above, 3.0 mm. long, 1.7 mm. wide, more or less pointed behind, clothed with fairly long light brown hair. White emulsion obstructs the view of the spinnerets and of the genital fold.

*Adulatrix parva*, n. sp. Plate LXVII, Fig. 604, Plate XLI, Figs. 392 to 397.

British Museum, collection from Samland, In. 18124. A fairly well preserved specimen showing most structures. There is a plane of cleavage on the abdomen. White emulsion covers the ventral surface and forms an envelope around the abdomen making it appear longer than in reality. In strong transmitted light the true outlines of the abdomen become visible. Portions of the fourth left leg had been polished off by the previous owner. The color of the chitin is yellowish brown with the legs and abdomen lighter and the chelicerae darker.

*Type.* Immature female. Total length with chelicerae 3.2 mm. Carapace 1.24 mm. long, 1.04 mm. wide, transversely truncated in front, with a longitudinal thoracic groove and a gentle posterior declivity. Free margins of head parallel (Fig. 395), wider than the eyegroup. The carapace is flat and the head is on the same level with the thorax, 0.64 mm. wide.

Eight eyes in two gently recurved rows. First row almost straight. Ratio of eyes AME:ALE:PME:PLE = 1.5:1.5:2:2.5. AME separated from each other by 2/1.5 of their diameter. Lateral eyes far apart. Quadrangle wider behind than in front and somewhat wider than long. A very stout bristle in the midline in front of the AME. The clypeus is quite low.

The chelicerae are stout, geniculated, with a boss and oblique margins. Basal joint 0.36 mm. long, clothed with bristles on the anterior surface. Mouthparts and sternum obstructed from view by emulsion. First coxae far apart, fourth coxae separated by at least half their width. None of the trochanters notched.

Leg formula	$\frac{4}{3.1}$	$\frac{2}{2.6}$	$\frac{1}{2.6}$	$\frac{3}{2.4}$
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	Femur	Pat. + Tib.	Metat.	Tarsus	Total
I	1.04	1.16	0.56	0.44	3.20
II	1.00	1.20	0.64	0.44	3.28
III	0.88	1.00	0.60	0.44	2.92
IV	1.04	1.36	0.84	0.56	3.80

Spines are few and slender. On the first leg only one pair is present, on the ventral surface of the metatarsus near base. On the fourth leg, in addition to the pair of ventral metatarsal spines there is a pair of small ventral tibial spines and a single dorsal spine on the patella near base. The legs are clothed with soft hair of various lengths.

Two claws, similar (Fig. 393), curved, with four stout teeth increasing in length distally. Claw-tufts wanting, but the ventral surface of the first and second tarsus shows a row of five or six stout, short, more or less erect bristles (Fig. 397) with tip bent backward. Between these bristles spatulate hairs (Fig. 396) form a very scanty scopula visible only under high magnification. Similar spatulate hairs are present on the distal half of the ventral surface of the first and second metatarsus. None are found on the third and fourth leg. The trichobothria are numerous, in two rows on tibiae and metatarsi, apparently in a single row on tarsi. The trichobothria increase distinctly in length distally on each joint.

The palpi are of the female type. The abdomen is ellipsoidal, 1.6 mm. long, 1.00 mm. wide, clothed with short, fine hair. Neither the spinnerets, nor the genital fold can be seen.

Specimen In. 18133 of the collection from Samland in the British

Museum probably belongs to this species, but is poorly preserved and defective.

Subfamily *Sparianthidinae*

Genus *Eostasina*, nov.

Closely related to the recent Genus *Stasina* from which it may be distinguished by the presence of three pairs of long, ventral spines on the metatarsi. From the recent Genus *Pseudosparianthis* it may be distinguished by the length of the above spines. First tibia with four pairs of ventral spines. Tarsi and metatarsi finely scopulate. Claw-tufts wanting. Two claws with teeth. Palp with a claw. To these characters may be added that the maxillae are parallel, the lip about as long as wide and the sternum more or less oval. The first coxae wide apart. Type *E. aculeata*.

*Eostasina aculeata*, n. sp. Plate LXVI, Fig. 596, Plate XXXIX, Figs. 368 to 371.

British Museum, collection from Samland, In. 18111.

*Type.* A single specimen, possibly an exuvium of a female. The specimen is poorly preserved in dark amber. The piece is of peculiar shape and has many imperfections. The amber is very dark around the specimen. The carapace is missing which suggests the possibility that the specimen is only an exuvium. Portions of some legs were polished off by the previous owner. The color of the chitin is light brown in some parts, and almost black in others. Total probable length between 8.5 and 9 mm. The sternum (Fig. 370) is somewhat convex, more or less oval, slightly narrowed in front, pointed behind. First coxae wide apart. Fourth coxae separated by about half their width. The chelicerae, visible from below, are stout and short. The maxillae are parallel. The lip is a little longer than wide, with rounded end, reaching a little beyond the middle of the maxillae. The palp is inserted near the base of the maxilla and has a slender claw with four fine teeth (Fig. 369).

The legs are laterigrade and fairly long. The chief characteristics are the long ventral spines on the first and second tibia and metatarsus. The tibia has four pairs, the first of which is the shortest, yet reaches to the base of the third pair. On the metatarsus (Fig. 371) three pairs of ventral spines are present. The first pair is the longest and reaches to the base of the third pair.

Other spines are present on the legs, but their arrangement cannot be ascertained on account of the imperfection of the specimen. The tarsi and metatarsi of the first and second pair of legs are very finely scopulate. Especially on one of the tarsi the scopula is plainly visible. Some hair is projecting under the claws, but true claw-tufts are wanting. Two trichobothria are visible on one of the tarsi. There are two claws present (Fig. 370) which are similar, strongly curved and supplied with a row of several teeth.

The abdomen is ellipsoidal. The spinnerets are missing, having been polished off by the previous owner.

#### Family THOMISIDAE

##### Subfamily *Dietinae*

##### Genus *Syphax* Koch and Berendt, 1854

##### Type *S. megacephalus* Koch and Berendt

Koch's original definition of the Genus *Syphax* is quite inadequate from the modern point of view. Thus he omits to mention the lip and the claw-tufts, two characters of primary value in this family. Were it not for this omission a new definition of the genus would be quite possible and desirable. As it is the species which Koch has described under the Genus *Syphax* cannot be placed in any of the now recognized subfamilies. Koch says that *Syphax* is related to *Xysticus* from which it may be differentiated by the very large anterior lateral eyes and by the relatively longer third and fourth legs. *Xysticus* belongs to the Subfamily *Thomisinae* (= *Misumeninae*) characterized by the lack of true claw-tufts, shortness of third and fourth legs and lesser disproportion of eyes. The species which I refer to the Genus *Syphax* and of which I give a detailed description below, has well developed claw-tufts, relatively long third and fourth legs, and quite large lateral eyes. Not having seen Koch's specimens I am unable to give a new definition of the genus. But I think that some day the genus will be found to belong to the Subfamily *Dietinae* in which it is placed here. At any rate it does not seem necessary to create a new genus when the characters given by Koch apply to the species described below.

Koch described five species of *Syphax* and four species of *Philodromus* as belonging to the Family *Thomisidae*. The status of



the Genus *Ocyptete* which Koch also placed in the Family *Thomisidae* was discussed above. It does not belong in the same family with *Syphax* and *Philodromus*. The five species of *Syphax* described and figured by Koch are *S. magacephalus*, *S. thoracicus*, *S. fuliginosus*, *S. gracilis* and *S. radiatus*. Menge, in a footnote on page 81 mentions also another species *S. hirtus* in his own collection, but this species remains a nomen nudum. *Syphax crassipes* described below as a new species cannot be placed in any of Koch's species, nor does it look like any of Koch's figures.

*Syphax crassipes*, n. sp. Plate LXIV, Fig. 583, Plate XXVII, Figs. 252 to 258. British Museum, In. 18722, collection Klebs 479, No. 13449.

*Type*. Immature male perfectly preserved in clear amber. Abdomen lightly coated with white emulsion. The color of the chitin is light brown, abdomen lighter. It is a stout looking spider with stout legs of the first and second pair.

Total length including chelicerae 4.25 mm. The length of the carapace cannot be measured because the posterior margin is hidden under the abdomen, but it is probably 2.2 mm. The width between the second and third coxae is 2.0 mm. The head is with parallel sides (Fig. 252) is truncated in front, 1.5 mm. wide. As a result the carapace has a peculiar shape. Its thoracic portion with bulging margins has the shape of a transverse ellipse. The head, while clearly set off from the thorax occupies about as large an area as the latter. Its complete outline cannot be traced because the cephalothoracic sulci are extremely shallow. It is difficult to get a side view of the spider because of the position of the legs. Figure 258 gives an idea of it and shows that the carapace is rather high and its posterior declivity steep. The carapace is clothed with short hair which becomes setose around the eyes and on the clypeus.

The eyegroup is much narrower than the head and is only 1.1 mm. wide. It is very prominent, being slightly elevated above the head, with the lateral eyes on a large common tubercle. The anterior median eyes are also elevated on a common, but less prominent tubercle. Only the posterior median eyes are on a level with the head. Both rows of eyes are gently recurved and the anterior row is somewhat shorter. Ratio of eyes AME: ALE: PME: PLE = 5:7:5:8. The quadrangle is much wider behind than in front, in ratio 21:16, and as long as wide behind. The AME are separated from each

other by their diameter and by the same distance from the ALE. The PME are separated from each other by two diameters and from the PLE by  $8/5$  of their diameter. The lateral eyes are separated from each other by the diameter of the ALE. The clypeus is flat and in the normal position of the spider gently slants forward. It is as high as two diameters of the AME. The entire face (Fig. 253), including clypeus and chelicerae, is quite flat.

The chelicerae are very stout at base, pyramidal, with strongly converging outer edges and diverging inner edges. A boss is wanting. The sides of the chelicerae are also flat. The surface is clothed with short, stiff hair and some long bristles are present on the inner edge. The margins cannot be seen. The fangs are short, very gently curved, slender.

The lip (Fig. 254) is longer than wide in ratio 8:7, fairly flat, with parallel sides in proximal half, converging in distal half. It is truncated in front and behind and fits into an excavation of the sternum. There is some hair on the anterior truncature and on the surface of the lip. The maxillae are parallel. However, their inner edge is more or less angular, so that the two opposite edges first converge almost as far as the end of the lip, then begin to diverge. A fairly dense scopula is present on the truncature of the maxillae. The palp is inserted near the base. The sternum is distinctly, but not strongly convex. It is longer than wide in ratio 26:20, more or less shield-shaped, pointed behind, with an excavation for the reception of the lip in front. The sternum is clothed with fairly long brown hair. The first coxae are wide apart. The fourth coxae are contiguous. The legs are laterigrade, stout.

Leg formula	1	2	4	3
	2.6	2.6	2.0	1.9

	Femur	Pat. + Tib.	Metat.	Tarsus	Total
I	1.80	2.20	0.96	0.72	5.68
II	1.80	2.20	0.96	0.72	5.68
III	1.40	1.60	0.72	0.56	4.28
IV	1.40	1.60	0.80	0.56	4.36

The width of the patellae cannot be measured and no tibial index can be given. To give an approximate idea of the stoutness of the legs the width of the first femur and that of the fourth may be compared as a ratio. Width of first femur 0.62 mm. Width

of fourth femur 0.38 mm. Ratio of length to width in the first femur is 3:1, in the fourth femur 3.6:1. The ratio between the widths is 62:38. The legs are clothed with rather stout hair of the simple kind. Plumose hair is wanting. The spines are short and stout (Fig. 255).

*Spines.* First leg. Femur dorsal 1-1-1, prolateral 1-1-1, elsewhere 0. Patella dorsal 1-1 small bristles, elsewhere 0. Tibia dorsal 0, prolateral 0-1 apical, retrolateral 1-1, ventral 2-2-2-2. Metatarsus dorsal 0, prolateral 1-1, retrolateral 1-1, ventral 2-2-2.

Second leg same as first, except tibia ventral 2-2-2, metatarsus ventral 1p-1p-2.

Third leg. Femur dorsal 0-0-1, prolateral 0-0-1, elsewhere 0. Patella dorsal 1-1 bristles, elsewhere 0. Tibia dorsal 1-1-0 bristles, prolateral 0-1, retrolateral 0, ventral 0-1 median apical. Metatarsus dorsal 0-1, prolateral 0-1, retrolateral 0-1, ventral 0-2, all together forming an apical verticellum of five spines.

Fourth leg same as third, except femur 0. Metatarsus retrolateral 0 so that the metatarsal verticellum is composed of only four spines.

Claws two, similar (Fig. 256), pectinate in a single row. The teeth are comparatively slender and long and about 14 in number. The claw-tufts are well developed and formed by true tenent hairs. Trichobothria are rather few, but long. Their arrangement is difficult to ascertain, as their distribution does not seem to be quite regular. Thus on the third tibia one can see the dorsal row running obliquely from the retrolateral side toward the middorsal line. But on account of the color of the chitin it is impossible to decide whether another row runs from the prolateral surface to meet the former in the midline. On the metatarsi and tarsi the trichobothria are arranged in a single row.

The palpi are rather stout and fairly long. The terminal joint is swollen, showing that it is an immature male in the penultimate instar. It is thickly clothed with stout bristles.

The abdomen is somewhat flattened above. It is widest in its anterior third. Posteriorly it converges gradually to a point. It is 2.6 mm. long, 2.0 mm. wide. It is clothed with fairly long and stout dark hair. The spinnerets (Fig. 257) are clearly visible. They are arranged in a rosette. The anterior pair are stout and cone-shaped, separated by a well developed colulus. The posterior spinnerets are less well visible. They are as long as the anterior pair. The median spinnerets are barely visible.

In front of the spinnerets transverse, slightly recurved plications of the abdominal wall may be seen. On reaching the sides these plications run forward and extend almost to the dorsal surface. They are more or less parallel to each other.

Subfamily *Thomisinae* (= *Misumeninae*)

Four genera of fossil spiders belong to this subfamily, *Misumena*, *Facundia*, *Filiola* and *Medela*. Of these *Misumena* is a recent cosmopolitan genus. It is possible that the amber species *M. samlandica* should be separated from the recent species and a new genus erected for it. But in that case the definition of the Genus *Misumena* would have to be revised and that does not seem to be desirable. The four species may be distinguished as follows:

1. First and second leg considerably longer than fourth leg 2
- \* Fourth leg longer than first and second leg ∴ . . . . . 3
2. Anterior median eyes contiguous not much smaller than the laterals. Legs without spines . . . . .  
*Misumena samlandica*.
- \* Anterior median eyes separated by more than two diameters, conspicuously smaller than the laterals. First pair of legs spinose . . . . . *Facundia clara*.
3. Eyes subequal, those of first row, subcontiguous, forming an almost straight line. Patella of second leg as long as tibia . . . . . *Filiola argentata*.
- \* Eyes of first row distinctly smaller, separated by about their diameter, forming a strongly recurved line. Patella of second leg distinctly shorter than tibia . . . .  
*Medela baltica*.

Genus *Misumena* Latreille, 1804

Type *M. vatia* (Clerck)

*Misumena samlandica*, n. sp. Plate LXVIII, Fig. 615, Plate XL, Fig. 379. British Museum, collection from Samland, In. 18120.

A fairly well preserved specimen in a piece of rather poor amber dark and full of reflections, but free of emulsion. Unfortunately the specimen is incomplete having been carelessly cut by a previous owner. The following parts are missing: the ventral surface of the abdomen with the spinnerets, a middle piece of the right first leg and a piece of the right second leg. The left first leg, the right third

leg and the left fourth leg are missing, but they were undoubtedly autotomized in life. The length of the first leg can be estimated because the relative position of the remaining portions of the leg in the amber has been naturally retained. The color of the chitin is dark brown with the abdomen yellowish grey with a silver sheen.

*Type.* Female. Total length including chelicerae 2.2 mm. Carapace 0.8 mm. long, 0.8 mm. wide between second and third coxae where it is widest, narrowed down in front to 0.48 mm. in the region of the eyes. The head is clearly set off from the thorax by deep cephalothoracic sulci. Its anterior edge is transversely truncated. The carapace is fairly high, the posterior declivity is steep and the posterior margin is concealed under the anterior end of the abdomen.

Eight eyes in two rows. The AME are on a common tubercle. They are subcontiguous and are separated from the ALE by a deep depression. The ALE are also subcontiguous and also on a common tubercle. The quadrangle is wider behind than in front. The clypeus is inclined and about as high as the quadrangle. The total width of the eyegroup is 0.38 mm. Unfortunately the eyes are very difficult to see in a proper position for measurement. All that one can say is that the first row is much shorter than the second row and that the eyes of the first row are distinctly smaller. The carapace is glabrous. There are four longitudinal rows of long, curved, brown bristles on the head. The two median rows are close to the median line, the lateral rows are near the edge of the head.

The chelicerae are wide open, with the fangs fully extended, but with the chitin badly decomposed. The basal joint is short, stout, with very oblique margins. Viewed from below one can see on both margins a scanty scopula, but no teeth. The fangs are slender, curved and pointed. The lip and maxillae are barely visible. The sternum is more or less oval, distinctly convex, somewhat narrowed in front, produced behind between the hind coxae which are separated by about their width. The first coxae are wide apart. There is an extraordinary disparity in the size of the two coxae of the first pair of legs. The left coxa is much smaller than the right one. It is both shorter and more slender. As I have mentioned above the left leg was evidently autotomized in life and is missing. But what arrested the growth of the left coxa remains, of course, a mystery. Two possibilities present them-

selves. Either the coxa was injured, the entire leg autotomized, the spider survived and a new, smaller coxa regenerated with a complete new leg, or else we are confronted with a teratological case.

The legs are laterigrade.

Leg formula	2	1	4	3
	5.5	5.4	4.5	3.7

	Femur	Pat. + Tib.	Metat	Tarsus	Total
I	1.20	1.30	1.10	0.72	4.32
II	1.30	1.40	1.00	0.68	4.38
III	0.92	0.88	0.68	0.44	2.92
IV	1.00	1.20	0.92	0.44	3.56

True spines are wanting, but the usual dorsal bristles are present, one on the patella and 1-I on the tibia. The legs are clothed with setose hair. The trichobothria are difficult to see. There is a row of about five trichobothria visible on the second metatarsus and at least one trichobothrium on the third tibia. Scopulae and claw-tufts are wanting. Two claws, similar, bent in middle, with a row of five teeth increasing in length distally. The palpi are rather long and slender, clothed with setose hair. The terminal joint ends in a claw which is stout, curved, with a row of five teeth.

The abdomen is globose, slightly flattened above, 1.3 mm. long, 1.3 mm. wide. It is sparsely clothed with very long, brown, curved bristles.

#### Genus *Facundia*, nov.

Eyegroup wider than head. Eight eyes in two rows. First row recurved and much shorter than second row which is straight. Anterior median eyes smallest, anterior lateral eyes largest. Quad-angle wider behind than in front, as long as wide. Lip wider than long. Sternum suborbicular. First coxae wide apart and appreciably larger than second and third coxae. Probable order of legs 1243. First leg spinose, second and third leg only with bristles. Claw-tufts wanting. Claws two, dissimilar. Palp with claw. Type *F. clara*.

(Derivation of name: Latin—facundia—eloquence.)

*Facundia clara*, n. sp. Plate LXVIII, Fig. 614. Plate XLIV, Figs. 415 to 421.

British Museum, collection from Samland, In. 18127.

A portion of a spider in fairly clear amber. The previous owner polished off the posterior portion of the cephalothorax and the entire abdomen. Missing also are the fourth pair of legs, the tibia of the left third leg and the posterior end of the sternum. There is an air-bubble under the right chelicera and maxilla and some white emulsion under the second and third right coxae. The rest of the spider is well preserved. Its characters are clearly shown, and demand the creation of a special genus. The spider is related to *Bomis*, a genus found only in Australia. The specimen is presumably an immature female. Its position in the amber gives the impression that the creature was trying to escape from the sticky gum in which it became entangled (Fig. 415). The color of the chitin is light rufous.

*Type.* Immature female. Probable total length of the spider between 2.0 and 2.5 mm. Since the carapace is incomplete its length can be only estimated on the assumption that it has the usual proportions, found in related species. This is facilitated by the possibility of giving an exact measure of the width between the second and third coxae, *i. e.* in a place in which the carapace is widest in a vast majority of spiders. In the case of this specimen it is 0.62 mm. wide. The probable length is therefore between 0.8 and 0.9 mm., probably nearer the former than the latter figure. The width of the eyegroup is a little greater than that of the head because the lateral eyes project on each side. That width is 0.43 mm. The carapace is fairly flat. All eyes are well visible (Fig. 419). They are arranged in two rows the first of which is recurved, the second straight and considerably longer. All eyes are prominent. Ratio of eyes AME:ALE:PME:PLE = 1:3:2.5:2.5.

The quadrangle is wider behind than in front in ratio 9:4.5 and about as long as wide. The AME are separated by two and a half diameters and by about half that distance from the ALE. The eyes of the second row are equidistant, separated from each other by  $3/2.5$  of their diameter. Viewed from in front (Fig. 417) the first row is straight by centers, the second row distinctly down-curved. The clypeus is equal to 3.5 diameters of the AME and therefore less than half the length of the quadrangle. There are several short bristles on the head: one pair between the PME, one bristle on each side of the head between the PME and PLE, one bristle on each side between the lateral eyes and one median bristle in front of the quadrangle on the clypeus. On examina-

tion under high power (Fig. 421) these bristles reveal the presence of short, pointed barbs arranged in rows.

The chelicerae are with oblique margins. It is impossible to see any armature or scopula. The lip is short and wide (Fig. 418). The sternum is incomplete, but seems to be suborbicular. The first coxae are large and far apart. None of the trochanters are notched. The probable order of legs is 1243.

	Femur	Pat. + Tib.	Metat.	Tarsus	Total
I	0.58	0.65	0.29	0.26	1.78
II	0.52	0.50	0.24	0.24	1.50
III	0.33	0.33	0.22	0.19	1.07
IV	?	?	0.24	0.22	?

Width of first patella 0.130 mm. First tibial index 20.

Width of second patella 0.120 mm. Second tibial index 24.

*Spines.* First leg. Femur prolateral 1 about one-third from end, elsewhere 0. Patella dorsal 1-1, elsewhere 0. Tibia dorsal 1-1-0, ventral 2-2-2-2, elsewhere 0. Metatarsus ventral 2-2-2, elsewhere 0. Second and third leg have no true spines. Trichobothria few. A row of three small ones on the tibia, the third one just beyond the middle, and a single trichobothrium on the metatarsus close to end. Claw-tufts wanting. Two claws, dissimilar (Fig. 420). Proclaw bent, with a row of from 14 to 16 equally long, fine teeth. Retroclaw also bent, but with only six short and stout teeth.

### Genus *Filiola*, nov.

Carapace considerably narrowed in front. Eyegroup transversely elliptic, much narrower than the head. Eyes of first row subcontiguous, forming an almost straight row. Eyes of second row slightly larger, forming a procurved row. Quadrangle wider behind than in front, as long as wide. Clypeus slanting, as high as the eyegroup. Chelicerae with oblique margins. Sternum convex, oval. First coxae very wide apart, fourth coxae separated by twice their width. Legs in order 4123. Patella of second leg as long as tibia. Spines wanting, but the usual dorsal bristles present. Claw-tufts wanting. Two claws. Palpal claw wanting. Six spinnerets. Colulus present. Type *F. argentata*.

(Derivation of name: Latin—*filiola*—a little daughter.)



*Filiola argentata*, n. sp. Plate LXVIII, Fig. 612, Plate XL, Figs. 380 to 385.

British Museum, collection from Samland, In. 18139—B.

*Type.* Female, probably immature. A single, well preserved specimen. Total length with chelicerae 1.32 mm. Carapace 0.63 mm. long (measured in reflected light at a magnification of 200 diameters), 0.50 mm. wide (measured in transmitted light at the same magnification). The carapace is narrowed in front to 0.25 mm. in the region of the eyegroup. The latter (Fig. 382) forms the highest point of the carapace, is transversely elliptic and only 0.20 mm. wide. The eyes are in two rows of almost equal length. The first row is so slightly recurved that it looks almost straight. The second row is distinctly procurved. Ratio of eyes AME: ALE: PME: PLE = 3.25: 3.50: 3.75: 3.75. The eyegroup is elevated on a common low tubercle. The AME are slightly separated from each other, but contiguous with the ALE. The PME are separated by their radius, but are subcontiguous with the PLE. The lateral eyes are separated by about a quarter of their diameter. The quadrangle is wider behind than in front in ratio 9: 6.5 and as long as wide. The clypeus is quite slanting, as high as the quadrangle.

The chelicerae are black, cone-shaped. Their basal joint is 0.17 mm. long. The outer edges (Fig. 380) are gently converging, the inner edges slightly diverging. The margins are oblique, but their armature is not visible. The fangs are slender and short. The maxillae are converging, but their view is obstructed by a palp and a tarsus. The lip cannot be seen. The sternum (Fig. 385) is convex, oval, rounded between the hind coxae. First coxae separated by a little less than the full width of the sternum. Fourth coxae separated by about twice their width. The sternum is glabrous. The legs are laterigrade.

Leg formula	4	1	2	3	
	2.8	2.4	1.9	1.7	
	Femur	Pat. + Tib.	Metat.	Tarsus	Total
I	0.43	0.48	0.34	0.29	1.54
II	0.36	0.38	0.24	0.24	1.22
III	0.26	0.29	0.29	0.22	1.06
IV	0.48	0.55	0.36	0.36	1.75

The second patella is as long as the second tibia.

The legs are setose, but true spines are wanting. The usual dorsal bristles are present, 1-1 on the patella and 1-1 on the tibia. Trichobothria cannot be seen on any leg and since the view of the legs is not obstructed, the conclusion seems to be inevitable that trichobothria are wanting. Claw-tufts are wanting. Two claws, apparently smooth but too difficult to see to be certain as to their structure. The legs are clothed with setose hair, as are the palpi, but the hair on the latter is not nearly as long. A palpal claw is wanting.

The abdomen (Fig. 383) is widest a little behind middle, fairly flat, 0.76 mm. long, 0.63 mm. wide, sparsely clothed with stout, dark brown bristles. Six spinnerets arranged in a rosette. Anterior and posterior spinnerets (Fig. 381) are of about equal length. The anterior spinnerets are separated by a distinct colulus, the posterior spinnerets by the full width of the anal tubercle which is large and as long as the spinnerets. The median spinnerets are small, but well visible. The ventral surface of the abdomen is sparsely clothed with very fine hair. The genital fold is almost transversely straight, very wide. The surface of the chitin on both sides of the abdomen, and particularly on the back, is minutely lined in a pattern resembling that of a human thumb-print.

Genus *Medela*, nov.

Carapace suborbicular, but much narrowed in front, flat, with a transversely ellipsoidal thoracic groove. First row of eyes strongly recurved and the eyes much smaller than those of the second row which is almost straight, much longer. Chelicerae short and weak. Sternum oval. First coxae wide apart, fourth coxae separated by their width. Legs in order 4123, without spines. Patellae shorter than tibiae, with strongly angular retrolateral edge. Type *M. baltica*.

(Derivation of name: Latin—medela—a remedy.)

*Medela baltica*, n. sp. Plate LXVIII, Fig. 611. Plate XLI, Figs. 386 to 391.

British Museum, collection from Samland, In. 18139—A.

*Type.* Female, presumably immature. A single specimen in amber which is perfectly clear above, but with white emulsion below. The piece was cut by me from a larger one and contains besides the spider a mite, a hymenopterous insect and a leg of another insect. The color of the chitin is light buff.

Total length 1.4 mm. Carapace (Fig. 386) 0.57 mm. long, 0.57 mm. wide between second and third coxae, suborbicular, narrowed down anteriorly to the width of the eyegroup which is 0.31 mm. and in front of the eyegroup still further to the width of the two AME. The carapace is rather flat, with a transversely ellipsoidal thoracic groove. The eyegroup has more or less the shape of a trapeze. When the spider is propped up so that the quadrangle is horizontal, then the AME project beyond the clypeus and the lateral eyes project beyond the lateral margins of the head. In that position the first row appears strongly recurved and the posterior row straight and much longer. In face view (Fig. 387) both rows are gently downcurved. Ratio of the eyes AME:ALE:PME:PLE = 2.5:3:4:4. The eyes of the first row are separated by about the diameter of the AME. The PME are separated from each other by their radius and by less than their radius from the PLE. The lateral eyes are separated by about the radius of the PLE. The quadrangle is wider behind than in front in ratio 10:7, wider than long in ratio 10:9. The first row of eyes is 0.25 mm. wide. The clypeus is concave. Its height cannot be measured, but appears to be at least as high as half the length of the quadrangle and possibly even higher.

The chelicerae are small and weak (Fig. 387) with oblique margins the armature of which cannot be seen. The view of the lip and maxillae is obstructed by emulsion. The sternum (Fig. 389) is covered by emulsion, but its outline is visible. It is more or less oval, longer than wide. The first coxae are wide apart. The fourth coxae are separated by about their width. The legs are laterigrade.

Leg formula	4	1	2	3
	5.1	3.9	2.9	2.4

	Femur	Pat. + Tib.	Metat.	Tarsus	Total
I	0.64	0.68	0.56	0.36	2.24
II	0.48	0.48	0.32	0.36	1.64
III	0.36	0.40	0.28	0.32	1.36
IV	0.80	1.08	0.60	0.40	2.88

The proportion of the legs is normal, the patellae are shorter than the tibiae. True spines are wanting, but the usual dorsal bristles are present on patellae and tibiae. The retrolateral edge of the patellae, especially of the fourth patella, is angular (Fig. 391).

Claw-tufts and scopulae are wanting. All hair is simple. The claws cannot be seen sufficiently well for study. The trichobothria are clearly visible, although very fine. There are several on the tibia, at least one on the metatarsus near base, none on the tarsus. The abdomen is somewhat flattened above, ellipsoidal, 0.9 mm. long, 0.6 mm. wide, very sparsely clothed with fine bristles.

Family *Drassodidae*  
(= *Drassidae*= *Gnaphosidae*)

Koch described two spiders under the Genus *Textrix* which he placed correctly in the Family *Agelenidae*. Menge refers both species to the Genus *Clythia*. In a footnote on page 46 Menge states that the Genus *Clythia* which Koch placed in the Family *Theridiidae* is closer related to *Ocypte*. We have seen above that *Ocypte* is now synonymized with *Olios* which is a genus of the Family *Eusparassidae*. Neither Koch, nor Menge were able to see the spinnerets in their specimens, nor did they consider the claws. Now it happens that *Agelenidae* have three claws and belong in the Branch *Trionycha*, while *Eusparassidae* have two claws and belong in the Branch *Dionycha*. To straighten out the confusion one would have to examine Koch's and Menge's type specimens, which I am unable to do. Fortunately the only spider placed here in the Family *Drassodidae* and described below belongs to a species which Koch described as *Textrix lineata*. The species is easily recognizable because of the parallel lines on the carapace. It belongs neither in the Family *Agelenidae* nor in the Family *Eusparassidae*, but in the family in which it is placed here. It is true that the spinnerets are missing, but the claws are well preserved, the maxillae show the characteristic oblique depression and the other characters either agree with or at least do not contradict the definition of the family. A new Genus *Captrix* had to be erected. The Genus *Clythia* could not be used because its familial position remains uncertain as long as the type has not been examined for its determining characters.

Subfamily *Drassodinae*  
Genus *Captrix*, nov.

Eyes in two rows. First row recurved, second row procurved. Eyes of first row contiguous. Laterals contiguous. Anterior median eyes largest, posterior median eyes smallest. Eyegroup

considerably narrower than the head. Quadrangle wider in front than behind, as long as wide. Chelicerae geniculated, with oblique margins. Lip wider than long, not reaching the middle of the maxillae. Maxillae parallel, with an oblique depression. Sternum considerably longer than wide. Legs prograde, probable order 4123. Spines present. First tarsus and metatarsus scopulate to base. No scopulae on third and fourth legs. Claw-tufts well developed. Two claws with teeth. Trichobothria numerous. All hair simple. Palp without claw. Type *C. lineata* (K. & B.).

(Derivation of name: Latin—captrix—an enfeeblor.)

*Captrix lineata* (Koch and Berendt), Plate LVIII, Fig. 539.

*Textrix lineata* Koch and Berendt, p. 48, Plate XVII, Fig. 145. British Museum, In. 18767, coll. Klebs 525, No. 13439.

*Type.* Mature female. A fairly well preserved specimen in clear amber with only the abdomen coated with white emulsion. The left first leg and both second legs were lost in life and are missing. The dirt in front of the corresponding coxae seems to be due to an exudation of blood. The tip of the abdomen had been cut off by the previous owner. It is a sturdily built spider with rather short and stout legs. The color of the chitin varies from light brown to black. Carapace black with a brownish tint. Chelicerae, maxillae, lip, sternum, coxae and genital region almost black. Abdomen light brown with dark brown hair.

Total length including chelicerae 7.12 mm. Carapace 3.04 mm. long, 2.28 mm. wide between second and third coxae where it is widest, 1.42 mm. wide in the region of the eyes. The carapace is very regularly curved in transverse section, very gradually narrowed anteriorly and posteriorly. The thoracic groove is deep, longitudinal. The eyegroup is much narrower than the head, the approximate width of the posterior row being only 0.9 mm. The first row is recurved, the second row gently procurved. It is impossible to measure the eyes exactly on account of the dark color of the carapace. Figure 137 represents the eyegroup as nearly as I was able to draw it with a camera lucida. It will be seen that the anterior median eyes are the largest, then come the lateral eyes which are subequal and finally the posterior median eyes which are by far the smallest. The eyes of the first row are contiguous and the laterals are also contiguous. The eyes of the second row are about equidistant, separated from each other by about a diameter

and a half of the PME. The quadrangle is somewhat wider in front than behind, and about as long as wide. Viewed from in front the first row is slightly curved downward and the clypeus is about as high as the diameter of the AME, possibly a little less. The carapace is clothed with hair which is apparently soft and recumbent and is arranged in parallel longitudinal rows. There is also a mid-dorsal row of dark bristles.

The chelicerae are powerful, strongly geniculated, apparently without boss, though this is not quite certain. Anterior surface clothed with stout bristles. Margins oblique, but their armature cannot be seen. The fangs are long and slender. The maxillae (Fig. 139) are parallel, which is unusual in the Family *Drassodidae*, but on the other hand they show clearly the typical oblique depression. A heavy scopula is present. The lip is free, wider than long, more or less rectangular. It does not reach the middle of the maxillae. The sternum is shield-shaped, longer than wide in ratio 21:15. It is distinctly narrowed in front, pointed behind between the fourth coxae which are subcontiguous. The sternum is slightly convex, clothed with bristles directed forward and inward. The first coxae are separated by the full width of the maxillae and lip. The probable order of the legs is 4123. The first leg is only 2.1 times as long as the carapace.

	Femur	Pat. + Tib.	Metat.	Tarsus	Total
I	2.00	2.37	1.32	0.76	6.45
II	?	?	?	?	?
III	1.61	2.18	1.28	0.84	5.91
IV	2.47	3.04	2.10	0.84	8.45

Width of first patella 0.378 mm. First tibial index 16.

Width of third patella 0.342 mm. Third tibial index 17.

Width of fourth patella 0.324 mm. Fourth tibial index 11.

*Spines.* First leg. Femur dorsal 1-1-1, the apical spine small, prolateral 0-0-1. No spines elsewhere on the leg.

Third leg. Femur dorsal 1-1-1, the apical spine small, prolateral 1-0-1, retrolateral 0-1-1, ventral 0. Patella 0. Tibia dorsal 0, prolateral 1-0-1, retrolateral 1-0-1, ventral 1p-2-2. Metatarsus dorsal 0, prolateral 1-1, retrolateral 1-1, ventral 2-2-0.

Fourth leg. Femur dorsal 1-1-1, prolateral 0-0-1, retrolateral 0-0-1, ventral 0. Patella 0. Tibia dorsal 0, prolateral 0, retrolateral 1-0-1, ventral 2-2-2. Metatarsus dorsal 0, prolateral 1-1, retrolateral 1-1, ventral 2-2-2.

First tarsus and metatarsus scopulate to base. Third and fourth leg without scopulae. Trichobothria numerous, in one row on tibiae in two rows on metatarsi and tarsi. Claw-tufts well developed (Fig. 138), as long as the claws. Two claws, similar, stout, strongly curved, with three teeth. The legs are clothed with three kinds of simple hair: 1) long, setose hair directed forward at an acute angle, 2) recumbent hair of the same appearance as on the body and 3) short, erect hair arranged in pairs on the ventral surface. There are four pairs of this type of hair on the metatarsi.

The palpi are spinose and hairy, but without claw. The abdomen is ellipsoidal, slightly depressed above, ca. 3.6 mm. long (the end is cut off), 2.8 mm. wide. It is clothed with brown setose and with recumbent hair. The epigynum (Fig. 136) is well visible and fully developed.

#### Family *Clubionidae*

This family as delimited by me is in many ways related to the preceding family. Koch still united in Sundevall's Family *Drasidae* genera which now are divided between at least four families. In his Monograph Koch lists two genera, *Macaria* (nom. preocc., now called *Micaria*) and *Clubiona*, which belong to the Family *Clubionidae* as now defined. Whether *Anyphaena fuscata*, described on page 64, is an *Anyphaena* cannot be decided without a close study of the type specimen. If it is, it does not belong, in my classification, in the Family *Clubionidae*, but in the Family *Anyphaenidae* in the Branch *Quadrostiatae*. Koch further describes two species of *Sosybius*, a genus which he placed in the Family *Eriodontidae* which has been incorporated long since in the Mygalomorph Family *Ctenizidae*. According to Menge both species of *Sosybius* are closely related to *Clubiona*. Menge names also a "new" Genus *Erithus* with a single species, *E. applanatus*, of which he gives no figure and only a brief description of the eyegroup without reference to any other characters. Identification of spiders belonging to the Family *Clubionidae* is not an easy matter. In the case of fossil spiders a most detailed description is necessary. From this point of view Koch's descriptions are quite inadequate. The species described below cannot be placed either in the Genus *Micaria* or the Genus *Clubiona*. Curiously enough it was possible to identify Koch's *Ocypete triguttata* as a species belonging to the Family *Clubionidae* and one which required the erection of a new genus.

Subfamily *Micariinae*

Three genera, *Massula*, *Ablator* and *Abligurator*, are placed here in the Subfamily *Micariinae*. They may be separated as follows:

1. Legs without scopulae. Integument without scales. Maxillae with parallel sides ..... *Massula*.
- \* Legs with scopulae at least on anterior tarsi and metatarsi. Integument with scales. Maxillae with a ventrolateral protuberance ..... 2
2. Third and fourth metatarsi without ventral spines. Legs in order 4123 ..... *Ablator*.
- \* Third and fourth metatarsi with two pairs of ventral spines. Legs in order 4231 ..... *Abligurator*.

Genus *Massula*, nov.

Carapace longer than wide, with longitudinal thoracic groove and evenly rounded lateral margins, about as wide in front as behind. Eyegroup narrower than head. First row of eyes recurved and shorter than second row. Eyes of first row contiguous. Clypeus vertical. Quadrangle wider behind than in front. Chelicerae with boss, geniculated, with oblique margins. Retromargin with three teeth. Maxillae parallel and with parallel sides, with well developed scopula. Lip rectangular, longer than wide. Sternum shield-shaped, longer than wide. First coxae separated by almost full width of mouthparts. Fourth coxae separated by half their width. Legs in order 4123. First and second metatarsi with a single pair of ventral spines. Third and fourth metatarsi with three pairs of ventral spines. Scopulae wanting. Claw-tufts well developed. Two claws, similar, with teeth. Six spinnerets, cylindrical, posterior pair longer than anterior pair. Colulus wanting. Integument with simple hair. Type *M. klebsi*.

(Derivation of name: Latin—massula—a little mass.)

*Massula klebsi* n. sp. Plate LXIV, Fig. 580. Plate XV, Figs. 140 to 147. Plate LXIII, Fig. 576.

1. Type. British Museum, coll. Klebs 504, No. 13486, In. 18746.
2. Paratype. British Museum, coll. Klebs 477, No. 13408, In. 18720.

*Type.* Mature male. A perfectly preserved specimen in clear amber. Unfortunately the previous owner polished off the knees



of two legs and the end of another leg. The color of the chitin varies from buff to dark rufous. Carapace dark rufous, chelicerae somewhat darker, legs yellow, abdomen yellowish grey with brown and white hair. Ventral surface altogether lighter except for the pregenital area which is darker than the rest. The spinnerets are rufous with a buff terminal joint.

Total length with chelicerae and spinnerets 5.5 mm. Carapace (Fig. 140) 2.4 mm. long, 1.9 mm. wide between second and third coxae where it is widest. Posterior margin concave. Anterior margin almost straight, 1.3 mm. wide in the region of the eyegroup. The lateral margins evenly curved anteriorly and posteriorly. The carapace is 0.9 mm. high at its highest point. From here forward it slopes gradually in an almost straight line. The posterior declivity is rather steep, beginning a little behind the thoracic groove which is longitudinal, short, line-like. The eyegroup is not as wide as the head. The first row of eyes is only 0.62 mm. wide, the second row 0.86 mm. The eyes are very transparent and difficult to see. Those of the first row which is distinctly recurved seem to be equal and contiguous. Those of the second row which is gently recurved, seem to be equidistant. The PME are slightly smaller than the PLE and are slightly farther apart from each other than from the PLE. The lateral eyes are separated from each other. Measurements are impossible on account of the transparency of the eyes. Viewed from in front (Fig. 141) the first row is upcurved, the second row gently down-curved. The quadrangle is wider behind than in front and apparently as long as wide. The clypeus is vertical, somewhat higher than the diameter of the AME. The carapace is clothed with recumbent hair which is white and directed forward and with a few bristles in the mid-dorsal line on the eyegroup.

The chelicerae are powerful, with a distinct boss. They are geniculated and almost parallel, with long, oblique margins. The basal joint is 1.4 mm. long, 0.55 mm. wide at base. The promargin is smooth, with a long, brown scopula. The retromargin is without a scopula, but has three black teeth (Fig. 146) well visible from below. The fangs are long, evenly curved, slender. The chelicerae are almost black, but owing to the transparency of the carapace one is enabled to see their cavity.

The maxillae are parallel, much longer than wide. There is a slight scopula on the inner edge. A longer scopula occupies the

oblique truncature and a tuft of long hair is on the extreme end of the maxilla. The outside edge shows long bristles. The surface of the maxillae is convex, without a trace of a depression. The lip is longer than wide, emarginate at the end which bears a few bristles. The sides are excavated near base. The basal suture is straight. The lip barely reaches the middle of the maxillae. The sternum is longer than wide in ratio 33:26. It is shield-shaped, with evenly convex sides meeting at a point between the hind coxae which are separated by half their width. The sternum is flat, sparsely clothed with short bristles. The first coxae are separated by not quite the width of the mouthparts. None of the trochanters are notched. The palp is inserted almost in the middle of the outer edge of the maxilla.

Leg formula	$\frac{4}{23}$	1 3.8	2 3.3	3 2.8
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	Femur	Pat. + Tib.	Metat.	Tarsus	Total
I	2.64	3.20	2.28	0.96	9.08
II	2.32	2.80	1.88	0.88	7.88
III	1.88	2.40	1.76	0.80	6.84
IV	2.40	3.00	2.72	1.00	9.12

The figure for the first tibia and patella is approximate. It cannot be measured because the knee had been cut off. The spines are few in number, but some of them are stout and long.

First leg. Femur dorsal 1-1-0, prolateral 0-0-1, elsewhere 0. Patella 0. Tibia ventral 2-2-2, elsewhere 0. Metatarsus ventral 2-0, elsewhere 0.

Second leg same as first, except metatarsus 0.

Third leg. Femur dorsal 1-1-0, prolateral 0-0-1, retrolateral 0-0-1, ventral 0. Patella dorsal 1-1 bristles, elsewhere 0. Tibia dorsal 0, prolateral 0-0-1, retrolateral 0-1-1, ventral 2-2-2. Metatarsus dorsal 0, prolateral 1-1, retrolateral 1-1, ventral 2-2-2.

Fourth leg same as third, except metatarsus dorsal 1 in middle. There are no scopulae on the legs. The legs are clothed with simple hair inclined at an angle forward, and with some shorter and more erect hair on the ventral surface of all metatarsi and tarsi. A great deal of recumbent hair is also present on the legs. Trichobothria are numerous and long, in two rows on tibiae, metatarsi and tarsi. A terminal dorsal membrane is present on the metatarsi (Fig. 144). Claw-tufts fairly well developed. Two claws, similar, curved, with three stout teeth (Fig. 143).

The abdomen is elongated, more or less truncated in front, pointed behind, slightly wider in middle than at the front. Total length without spinnerets 2.44 mm. Maximum width 1.52 mm. There are bristles on the front of the abdomen. The back is clothed with recumbent white hair and scattered brown bristles. On the ventral surface one can see clearly the two lungs and the gently procurved genital fold with the oval genital opening. Behind the genital region the venter is clothed with recumbent hair, white and buff, while the chitin of the abdominal wall itself is silvery white. Six spinnerets, cylindrical and long. The anterior pair (Fig. 147) is separated by about half their width. The terminal joint is rounded and bears only common spinning tubes. The posterior pair is somewhat longer, with a rounded terminal joint which bears in addition to common spinning tubes several stout spigots. The median pair is small and bears at least one spigot. The length of the anterior spinnerets is 0.43 mm., that of the posterior ones 0.50 mm. The anal tubercle (Fig. 145) is cone-shaped and much shorter than the spinnerets. A colulus is wanting. The petiolus is plainly visible from above.

The right palp is complete. Two dorsal spines and one retrolateral spine are present on the femur. On the patella the usual 1-1 dorsal bristles are present as well as a stout prolateral spine. There are at least three spines on the tibia which is cylindrical, longer than the patella and supplied with a retrolateral, apical, pointed apophysis. The cymbium (Fig. 142) is as long as the patella and tibia together. It is nearly oval, with three spines on its prolateral surface, the distal spine easily mistaken for the embolus. The latter originates from the base of the bulb as shown in Fig. 142 and is thorn-like. The back of the cymbium is clothed with short hair.

*Paratype.* British Museum, In. 18720, coll. Klebs 477, No. 13408. Plate LXIII, Fig. 576.

Mature male. A well preserved specimen in clear amber with a little white emulsion on the sternum and mouthparts. The piece is of peculiar shape causing distortion of the image in many positions. The color of the chitin is generally rufous. The chelicerae are dark brown. The abdomen is somewhat lighter than the carapace. Venter light rufous with brown spinnerets.

Total length including chelicerae 4.8 mm. Carapace 2.05 mm.

long, 1.76 mm. wide. Head with almost parallel sides, 1.0 mm. wide. Thoracic groove deep, longitudinal. Head on about the same level with the thorax. Cephalothoracic sulci barely noticeable. Carapace clothed with recumbent, short, soft hair directed forward and inward. A few scattered fine bristles are present on the carapace and a transverse row of eight bristles on the clypeus. There is a long median bristle between the anterior median eyes. The eyes are transparent and difficult to see. The first row is recurved, the second row gently procurved. It is longer than the first row, but the eyegroup is not as wide as the head. The quadrangle is wider behind than in front. Measurements are impossible, but the eyes of the first row look a little larger than those of the second row which are equal and equidistant. The clypeus is as high as the diameter of the AME.

The chelicerae are parallel. The boss is not visible. The basal joint is 0.8 mm. long. The margins are oblique, their armature cannot be seen. Fangs, lip and maxillae hidden from view by emulsion. Leg without scopulae.

Leg formula	4	1	2	3
	4.0	3.4	3.3	3.1

	Femur	Pat. + Tib.	Metat.	Tarsus	Total
I	1.90	2.60	1.60	0.84	6.94
II	1.90	2.56	1.60	0.80	6.86
III	1.80	2.28	1.60	0.76	6.44
IV	2.20	3.00	2.20	0.80	8.20

Width of first patella 0.240 mm. First tibial index 9.

Width of fourth patella 0.336 mm. Fourth tibial index 11.

Spines numerous and long, especially on the femur.

First leg. Femur dorsal 1-1-0, prolateral 1-1-1, elsewhere 0. Patella dorsal 0-1, elsewhere 0. Tibia ventral 2-2-0, elsewhere 0. Metatarsus ventral 2-0, elsewhere 0.

Second leg same as first, except femur prolateral 0-1-1, retrolateral 0-1-0.

Third leg. Femur dorsal 1-1-0, prolateral 0-1-1, retrolateral 0-1-1, ventral 0. (The first prolateral spine and the first retrolateral spine much smaller than the dorsal spines situated between them.) Patella 0. Tibia dorsal 0, prolateral 0-1-1, retrolateral 0-1-1, ventral 2-2-2. Metatarsus dorsal 0, prolateral 1-1, retrolateral 1-1, ventral 2-2-2.

Fourth leg femur dorsal 1-1-0, prolateral 1-0-1, retrolateral 0-0-1, ventral 0. Patella dorsal 1 long bristle, retrolateral 1 bristle in middle. Elsewhere 0. Tibia dorsal 0, prolateral 1-1, retrolateral 1-1, ventral 2-2-2. Metatarsus dorsal 0, prolateral 0-1-1, retrolateral 1-1-1, ventral 2-2-2.

Two claws, similar, with three or four teeth. Claw-tufts well developed. Trichobothria numerous, in two rows on tibiae, metatarsi and tarsi.

Abdomen elongated, pointed behind, 2.32 mm. long, 1.20 mm. wide in middle, clothed with soft recumbent hair and more or less erect bristles. Spinnerets cylindrical, fairly long. Anterior pair slightly stouter and distinctly shorter than posterior pair. Anterior pair contiguous. Colulus wanting. On the ventral surface of the abdomen two pairs of parallel rows of white dots are visible. These dots correspond to similar dots found in many recent spiders and often interpreted as attachment points of dorsoventral muscles. The interpretation is not correct, however, in view of the fact that the number of dots greatly exceeds the number of dorsoventral muscles known to exist. The two inner rows are almost parallel and extend from a little behind the petiolus to about the beginning of the last quarter. The outer pair is shorter. The presence of these dots in the paratype has no specific value. It is the only case known to me among amber spiders in which the dots are preserved. The fact that they are not visible in the type does not mean that they are wanting, but merely that they cannot be seen because of the transparency of the chitin.

The position of both palpi is such that the bulb can be seen only in profile and the embolus cannot be seen at all. However, the tibial retrolateral apical apophysis has the same shape as in the type and can be plainly seen. It is very dark, slightly curved inwards and sharply pointed.

#### Genus *Ablator*, nov.

Carapace longer than wide with almost circular thorax and much narrower head. Thoracic groove longitudinal. Eight eyes in two gently recurved rows. Quadrangle wider behind than in front. Chelicerae with oblique margins. Lip longer than wide. Maxillae with a ventro-lateral protuberance. Sternum oval, longer than wide. First coxae wide apart. Legs in order 4123, with spines. Tarsal and metatarsal scopulae present on anterior legs.

Claw-tufts present. Two similar claws with teeth. Six spinnerets. Anterior pair contiguous, stouter and somewhat longer than posterior pair. Colulus wanting. Integument with scales. Embolus of male palp long and slender. Type *A. triguttatus* (Koch and Berendt).

(Derivation of name: Latin—Ablator—one who takes away.)

*Ablator triguttatus* (Koch and Berendt).

*Ocyrete triguttata* Koch and Berendt, 1854, p. 86. Plate XVI, Fig. 141.

Two specimens in the British Museum, both mature males. Specimen In. 18751, coll. Klebs 509, No. 13426, is the Hypotype and Genotype. Specimen In. 18766, coll. Klebs 524, No. 13409, is the Parahypotype.

Description of Genotype, In. 18751. Plate LXVI, Fig. 598, Plate XXIV, Figs. 223 to 228. A well preserved specimen in fairly clear amber. The left third leg was autotomized when the spider was caught in the gum, is complete and lies a little in front, under the first left leg. There is some white emulsion on the mouthparts and on the abdomen. The color of the chitin is brown of various shades. Carapace very dark, legs somewhat lighter, abdomen light brown. Chelicerae almost black with red-brown scapula.

Total length with chelicerae 4.0 mm. Carapace 1.8 mm. long, 1.56 mm. wide between second and third coxae where it is widest. Thoracic portion almost circular. The head is 0.67 mm. wide and the transition from thorax to head is more or less sharp. The thoracic groove is deep, longitudinal. The posterior declivity rather steep. The greatest height of the carapace is in the region of the thoracic groove. From here on it slopes forward in an almost straight line. Although on the same level with the thorax, the head is clearly delimited by shallow cephalothoracic sulci. The lateral margins of the carapace are narrowly, but distinctly flattened, forming a well visible border. The surface of the carapace looks at first glance glabrous, but more careful inspection reveals the presence of very short hair in places.

The eyegroup is 0.57 mm. wide and therefore narrower than the head. The eight eyes form two gently recurved rows, the first shorter than the second. Anterior median eyes slightly but distinctly separated from each other, contiguous with the ALE. The eyes of the first row are apparently of the same size as the poste-

rior lateral eyes, while the PME seem to be slightly smaller and the distance between them is distinctly greater than the distance between the PLE and PME. The lateral eyes are far apart. Because of the color of the chitin the study of the eyes is difficult, but the PME seem to be flat. The quadrangle is wider behind than in front, as long as wide. The clypeus is slightly concave and a fraction higher than the diameter of the AME. Viewed from in front both rows appear slightly downcurved. There are a few bristles on the clypeus and on the eyegroup.

The chelicerae are rather long and slender. The basal joint is 0.62 mm. long. No boss can be seen. The outer edges of the chelicerae are parallel, but the inner edges are diverging. The margins are oblique, but their armature cannot be seen. A long, red-brown scopula is present on the promargin and some stiff bristles on the anterior surface. Looking at the chelicerae from below in a beam of strong light one can see at least one tooth on the retro-margin. The lip (Fig. 224) is more or less hexagonal, narrower in front than at base and somewhat longer than wide. Of the maxillae only the left one is visible, the view of the right maxilla being obstructed by the right palp. The maxilla has a knob or protuberance directed ventro-laterally. The oblique truncature of the maxilla is covered with a dense scopula visible through the emulsion. The palp is inserted almost at the distal end of the maxilla. The maxilla is distinctly wider in front than at the base. The sternum is oval, truncated in front, pointed behind between the fourth coxae which are separated by about half their width. The sternum is longer than wide in ratio 25:21, slightly, but distinctly convex and glabrous. The first coxae are wide apart. All femora are somewhat distended dorsoventrally near base.

Leg formula	4	1	2	3
	3.7	3.0	2.9	2.9

	Femur	Pat. + Tib.	Metat.	Tarsus	Total
I	1.44	2.00	1.08	0.84	5.36
II	1.44	2.00	0.96	0.84	5.24
III	1.36	1.76	1.20	0.84	5.16
IV	1.60	2.08	1.92	1.00	6.60

Width of first patella 0.264 mm. First tibial index 13.

Width of fourth patella 0.280 mm. Fourth tibial index 13.

Under low power the legs appear to be almost glabrous, but under high power one can see that they are clothed with exceedingly short, spine-like hair arranged in rows, about nine rows on each side of the leg. One can also see under high power a scopula on the legs. The scopula is composed of very short hair. On the first and second leg it occupies the full length of the tarsus and metatarsus and extends over the distal half of the tibia. On the third leg the scopula occupies the complete length of the tarsus and the distal third of the metatarsus. On the fourth leg a scopula is completely wanting.

*Spines.* First leg. Femur dorsal 1-1-0, prolateral 0-0-1. Tibia ventral 2-2-2-2 very small spines, barely visible. No spines elsewhere on this leg.

Second leg same as first.

Third leg. Femur dorsal 1-1-0, elsewhere 0. Patella 0. Tibia ventral 1-1-1, elsewhere 0. Metatarsus prolateral 1-2, retrolateral 1-1, elsewhere 0.

Fourth leg same as third.

Two claws (Fig. 223) similar, curved, with four blunt teeth. Claw-tufts composed of a few tenent hairs, about 10 or 12 on each tarsus. Trichobothria numerous and long, in one row on tibiae and metatarsi, in two rows on tarsi.

The abdomen is elongated, with more or less evenly curved sides, widest in middle and somewhat narrower behind than in front, but rounded at both ends. It is 2.1 mm. long, 1.3 mm. wide. In the area which is free from emulsion one can see that the surface of the abdomen is densely clothed with white scales which look in reflected light like mother-of-pearl. The ventral surface seems to be free of scales and is clothed only with simple hair. Six spinnerets (Fig. 227). The anterior spinnerets are stouter and somewhat longer than the posterior ones. They are cone-shaped, contiguous at base, with hemispherical terminal joint. The posterior spinnerets are cylindrical, slender. The median ones are barely visible. A colulus is wanting.

The most characteristic features of the spider are the palps, both of which are in perfect condition, and so placed that every feature of their structure may be seen in detail. The femur is curved dorso-ventrally (Fig. 225). The tibia is only a little longer than the patella. It has two prolateral bristles and a large and pointed retrolateral apophysis. When examined from the dorsal side it appears



quite narrow (Fig. 228). The cymbium is about as long as the femur. It is spoon-shaped and clothed with short hair. The embolus is long, needle-like and curved. It arises in the middle of the bulb, has a wide base like an ampulla, runs first downward and then turns upward. There are three hooks on the bulb. One of these, marked with the figure 1, is evenly curved. Another, marked 2, is S-shaped and twisted. Its end is in contact with the preceding hook. The third hook arises lower on the bulb, has a much broader base and almost reaches the ends of the other two hooks from below, so that taken together the three hooks look like a grasping apparatus. The S-shaped hook is lighter in color than the other two, while the lower hook is longitudinally ridged on the inside. Koch mentions only two curved hooks in his description, but since two of the hooks are closely applied to each other one does not notice the presence of three hooks at a first glance and Koch did not have instruments comparable to those in use at present. He also describes the presence of three white spots on the back of the abdomen. It seems probable that in his specimen the white scales were rubbed off except in three places.

*Parahypotype*, In. 18766, Plate LXIV, Fig. 582. Plate XXIV, Figs. 219 to 222. A very well preserved specimen. The view of the palpi and of the mouthparts is obstructed by white emulsion. The ventral surface of the abdomen is caved in and the spinnerets are coated with emulsion. The color of the chitin is brown of various shades.

Total length 4.1 mm. Carapace (Fig. 219) 2.0 mm. long, 1.76 mm. wide between second and third legs, 0.68 mm. wide in the region of the eyes. Thoracic longitudinal groove deep. The thoracic portion almost circular. The posterior margin straight. The lateral margins distinctly flattened. The cephalothoracic sulci shallow and the entire carapace rather flat. The eyegroup narrower than the head. Eight eyes in two gently recurved rows. Ratio of eyes AME:ALE:PME:PLE = 6:6:5:6. The AME are separated by their radius and their bases form a more or less right angle, so that each AME looks upward and outward, their axes diverging. A fairly deep cleft separates the AME from the ALE which look forward, downward and outward. The PME are fairly flat and look upward and somewhat outward. The PLE are almost on the same plane and look outward almost at right angles

to the plane of symmetry and slightly upward. The quadrangle (Fig. 220) is wider behind than in front in ratio 14:10, wider than long in ratio 14:12. The clypeus is slightly concave.

Leg formula	4	1	2	3
	3.7	3.0	3.0	2.8

	Femur	Pat. + Tib.	Metat.	Tarsus	Total
I	1.68	2.20	1.20	0.88	5.96
II	1.68	2.20	1.20	0.88	5.96
III	1.60	1.80	1.32	0.88	5.60
IV	1.80	2.40	2.00	1.12	7.32

Width of first patella 0.264 mm. First tibial index 12.

Width of fourth patella 0.240 mm. Fourth tibial index 10.

Distribution of spines same as in Hypotype. Abdomen 2.1 mm. long, 1.3 mm. wide in posterior third where it is widest. The back is thickly clothed with white scales (Fig. 222) which look like mother-of-pearl in reflected light. Ventral surface clothed only with short hair. The hair is of the simple kind and of brown color. On the pregenital area it is coated with white emulsion giving it the appearance of white color. However, when examined under high power in reflected light the true color becomes apparent. The palp, as far as one can see it, has the same structure as in the Hypotype. The tibial apophysis is shown in sideview in Figure 221. The hooks on the bulb are present, but cannot be seen well.

#### Genus *Abliguritor*, nov.

This genus is closely related to the preceding one, from which it may be distinguished by the following characters: The carapace has no flattened edge. The clypeus is equal to two diameters of the AME. The quadrangle is as wide in front as behind. The sternum is convex, longer than wide, truncated in front. The maxillae are shorter, but have more or less the same type of ventrolateral protuberance. Order of legs 4231. Third and fourth metatarsi with two pairs of spines. Tarsal and metatarsal scopulae present on all legs. Claw-tufts present, but poorly developed. Two similar claws with teeth. Trichobothria numerous and long. Embolus of male palp in the shape of a long, curved needle. Type *A. niger*.

(Derivation of name: Latin—abliguritor—a spendthrift).

*Abbiguritor niger*, n. sp. Plate LXI, Fig. 561, Plate XVI, Figs. 155 to 159.

British Museum, collection from Samland, In. 18119.

*Type.* Mature male. A well preserved specimen in dark amber. The previous owner polished off the first left leg across its tibia. Otherwise the specimen is complete. The color of the chitin is almost black, making examination of some structures difficult.

Total length 4.27 mm. Carapace (Fig. 157) 2.0 mm. long, 1.74 mm. wide between second and third coxae, 0.72 mm. wide in the region of the eyegroup. The carapace is flat and its thoracic portion looks almost circular. The head is slightly lower than the carapace, but with distinct sulci separating it from the thorax. Thoracic groove longitudinal. Posterior declivity short. The carapace is free of hair, but a few slender bristles are present on the eyegroup.

The eyegroup is narrower than the head. It can be studied under high power in a combination of reflected and transmitted light and the measurements can be made only in side-view. Both rows are gently recurved. The eyes of the first row are contiguous. The first row is shorter than the second row. The total width of the eyegroup is 0.58 mm. The AME are a fraction larger than the ALE. The PME are still smaller. The approximate ratio of eyes AME:ALE:PME:PLE = 5.25:4.5:3.5:4.5. The quadrangle is as wide in front as behind, wider than long in ratio 15:13. The eyes of the second row are separated by about the diameter of the ALE and the laterals are separated by about the same distance. The clypeus is equal to about two diameters of the AME.

The chelicerae are comparatively slender, with a boss. Their outer edges are parallel, their inner edges diverging. A few stout bristles are present on the front surface. The margins are not visible, but three long bristles are plainly visible at the distal end of the promargin. The fangs are slender and fairly long. The lip appears to be as long as wide. The maxillae (Fig. 159) have a strong ventrolateral protuberance facing the first coxae. The sternum is convex, shiny, longer than wide in ratio 30:25, truncated in front, drawn out to a point between the hind coxae which are separated by half their width. The first coxae are wide apart.

		2	3	1
Leg formula	3.9	3.2	3.1	2.8

	Femur	Pat. + Tib.	Metat.	Tarsus	Total
I	1.80	1.60	1.28	0.96	5.64
II	1.88	2.30	1.24	0.96	6.38
III	1.60	2.00	1.56	0.96	6.12
IV	2.20	2.20	2.20	1.12	7.72

Width of first patella 0.240 mm. First tibial index 15.

Width of fourth patella 0.240 mm. Fourth tibial index 11.

*Spines.* First leg. Femur dorsal 1-1-0, prolateral 0-0-1, elsewhere 0. Patella dorsal 1 apical bristle, elsewhere 0. Tibia ventral 1p-2-2-2-2 minute spines, the first one standing out at right angles, elsewhere 0. Metatarsus 0.

Second leg same as first.

Third leg. Femur dorsal 1-1-0, elsewhere 0. Patella dorsal 1 apical bristle, elsewhere 0. Tibia ventral 1p-2-2, the first one standing out at right angles, elsewhere 0. Metatarsus ventral 2-2, elsewhere 0.

Fourth leg same as third.

All tarsi and metatarsi distinctly scopulate to base. First tibia delicately scopulate in distal two-thirds, second tibia in distal half, third tibia in distal third. Fourth tibia without a scopula. Two claws, (Fig. 158) similar, curved, with four teeth. Claw-tufts comparatively poorly developed, composed of hairs indistinguishable from those of the scopulae. On all tarsi and metatarsi a ventral row of hairs is present which are slightly longer than those of the scopula and protrude beyond the latter at more or less equal intervals. The trichobothria are numerous and long, especially on the second and third leg. They are in two rows on the tarsus, increasing in length distally, apparently in a single row on metatarsi and tibiae. The legs are clothed with short, almost spine-like hair.

The abdomen is elongated, 2.4 mm. long, 1.4 mm. wide in posterior third, narrowing forward gradually and backward more rapidly so that the posterior end is pointed. The abdomen is slightly flattened and is thickly clothed with white scales which look like mother-of-pearl in reflected light. They are difficult to see under low power, but stand out clearly under high power. The ventral surface of the abdomen is partly obstructed from view by white emulsion, partly caved in. Consequently the spinnerets are

difficult to see. If my interpretation based on what remains visible is correct, the anterior spinnerets are cylindrical and are separated at base.

The palp is large and very characteristic (Fig. 156). The femur is strongly curved dorso-ventrally and armed with a prolateral and a dorsal spine. The patella is somewhat stouter than the femur. The tibia has a narrow base about half as wide as the patella. It widens anteriorly and has a very large retrolateral apophysis (Fig. 155). The cymbium (Fig. 156) is almost as long as the rest of the palp and has an immense copulatory apparatus. Its structure is hidden from view by the position of the palp, but one can see the embolus which is long, needle-like, slightly curved.

#### *Clubionidae Incertae Sedis*

I am forced to leave unclassified a new Genus *Desultor* because some of the characters cannot be seen. Since, however, the specimen on which the new genus and species are based is a mature male with clearly visible palpi, the species can be recognized. If, therefore, another, better preserved specimen were found, the genus could be assigned to a proper subfamily.

#### Genus *Desultor*, nov.

Carapace almost circular, fairly flat. Eyegroup much narrower than head. Eight eyes in two recurved rows. PLE largest. Quadrangle much wider behind than in front. Chelicerae strongly geniculated, short and stout, with oblique margins. Sternum flat, oval, very slightly longer than wide. First coxae far apart. None of the trochanters notched. Legs in order 4123. Two similar claws with teeth. Abdomen ellipsoidal. Six spinnerets. Anterior pair as long as posterior pair. Type *D. depressus*.

(Derivation of name: Latin—desultor—a changeling.)

*Desultor depressus*, n. sp. Plate LXII, Fig. 572, Plate XX, Figs. 193 and 194.

British Museum, In. 18756, coll. Klebs 514, No. 13411.

A badly distorted specimen with a great deal of air in all appendages and in the amber itself. Small black crystals cover the

sternum and some other parts. White emulsion on chelicerae and mouthparts. The chief peculiarity of the specimen is to be found in the fact that some of the legs are distended by air. The specimen is not an exuvium and the distension must have taken place *after* the disintegration of the tissues. Perhaps the spider was only partly entangled in the gum, possibly with its ventral side only. Struggling to get free he may have been unable to autotomize his legs and perished with his back still exposed to air. If he remained in that condition until all tissues disintegrated, gas produced by decomposition may have filled and distended the legs. All that remained necessary for preservation of the specimen was new accumulation of gum on the back of the spider. A curved plane in the amber under the spider seems to give support to this interpretation. The color of the chitin is light yellow.

*Type.* Mature male. Total length 5.2 mm. The carapace is badly distorted, 2.3 mm. long, 2.2 mm. wide. However, if measured from the thoracic groove to the right edge, *i. e.* on the side where distortion is least, and this figure considered to represent half of the width, the width would be only 2.0 mm. In the condition in which the carapace is, it has the appearance of a circle with the eyegroup much narrower than the head. The carapace is rather flat and slopes gently forward in a straight line, while the posterior declivity is somewhat steeper and short.

The eyegroup is 0.62 mm. wide, but the individual eyes are pressed out of shape almost beyond recognition. As far as one can judge the PLE are the largest ones, the other eyes being all equal. The first row is slightly recurved, the second row a little more so and distinctly longer. The lateral eyes are separate. Between the AME and ALE is a deep cleft. The quadrangle is considerably wider behind than in front and about as long as wide. The clypeus is distorted.

The chelicerae are rather short and stout, strongly geniculated. The margins are oblique, their armature cannot be seen. The fangs are curved. The maxillae and lip are badly distorted. The only certain thing seems to be the insertion of the palp toward the end of the maxilla and not at its base. The sternum is oval, flat, slightly longer than wide in ratio 16:15. It is rounded behind, in front of the fourth coxae which are subcontiguous. The first coxae are wide apart. None of the trochanters are notched.

Leg formula	4	1	2	3
	3.4	3.0	2.6	2.5

	Femur	Pat. + Tib.	Metat.	Tarsus	Total
I	2.00	2.80	1.40	0.80	7.00
II	1.60	2.20	1.40	0.76	5.96
III	1.52	2.00	1.32	0.84	5.68
IV	2.12	2.52	2.12	0.96	7.72

Width of second patella 0.160 mm. Second tibial index 7.

Width of third patella 0.160 mm. Third tibial index 8.

The other patellae cannot be measured.

The legs are clothed with short hair. Spines are present, but their arrangement cannot be ascertained, because of the distortion of the legs. Neither is it possible to determine whether any scopulae are present, except in the case of the fourth right leg where there is some indication of one. Claw-tufts well developed. Two similar claws, curved, with three teeth.

Abdomen ellipsoidal, somewhat flattened and pressed out of shape, 2.6 mm. long, 1.7 mm. wide, evenly rounded behind. The spinnerets are badly distorted. The anterior spinnerets are contiguous. The posterior pair are about as long as the anterior pair.

The palpi are stout. The tibia (Fig. 193) has a large prolateral apophysis with an apical pointed tooth. The cymbium is larger than the patella and tibia together. The bulb has a rather complex structure better understood from Figure 194.

#### Family *Salticidae* (= *Attidae*)

The *Salticidae* form one of the best delimited and largest families of spiders. Apart from minor modifications the disposition of their eyes is so constant and so characteristic that a Salticid may be recognized at a glance. When it comes to finer classification within the family the matter is not at all so simple. As I have pointed out on several occasions Simon's divisions and subfamilies are so artificial that one is tempted to use some other principle of classification were it not for the fact that this would require a careful study of extensive material. The attempts of other arachnologists to find a satisfactory principle of subdivision were all so limited in scope that they are practically useless. In my *Systema Aranearum* and *Catalogue of American Spiders* I followed Simon's

classification with minor changes in the characterization of sub-families and the placement of genera.

The species which Koch described undoubtedly belong to the Family *Salticidae*. He mentions two genera, *Phidippus* and *Leda*. Of the Genus *Phidippus* Koch described nine species reduced by Menge to five owing to synonymy. These five are *P. frenatus*, *P. melanocephalus*, *P. marginatus*, *P. fasciatus* and *P. gibberulus*. Menge lists in addition eleven other species of *Salticidae* distributed over eight genera seven of which are *nomina nuda* both as to genus and species and the eighth containing four *nomina nuda* of species under the generic name of *Attus*. None of these, of course, can be placed. They are merely listed on page 8 and briefly discussed in the second footnote on page 94.

Although Menge's List on page 8 still uses the Genus *Phidippus*, he denies the existence of the genus in the Baltic amber and refers Koch's species to the Genera *Gorgopis* Menge and *Euophrys* Koch. At the same time Menge gives, without any valid reason, new names to Koch's species. Thus *Phidippus frenatus* Koch = *Gorgopis torva*, *P. melanocephalus* Koch = *Gorgopis lynx*, *P. marginatus* Koch = *Gorgopis marginata* and *P. fasciatus* Koch = *Gorgopis fasciata*. *Phidippus gibberulus* Koch Menge calls *Euophrys gibberula*. In addition to these Menge mentions 27 specimens of *Salticidae*, which he placed in a new Genus *Propetes* characterized by the large size of the eyes of the second row. This genus according to Menge is represented in the Baltic amber by five species, *P. felinus*, *P. argutus*, *P. griseus*, *P. latifrons* and *P. pumilus*. The name *Propetes* was preoccupied by Walker in 1851 for an insect. The specific names are *nomina nuda*.

Division *Unidentati*  
Subfamily *Heliophaninae*  
Genus *Parevophrys*, nov.

Retromargin of chelicerae with a single, pointed tooth. Pro-margin smooth. Petiolus inconspicuous. Third coxae close to second coxae. All patellae shorter than femora. Fourth leg presumably longer than third leg. Fourth patella + tibia longer than third patella + tibia. Anterior truncature of the sternum equal to the width of the lip. Fourth coxae contiguous. Sternum flat, much longer than wide. Probable order of legs 4312. Spines



numerous. First pair of ventral spines on first and second tibia close to base, third pair apical. Third and presumably fourth metatarsus with an apical verticellum of six spines. Width of eyegroup distinctly smaller than width of head. Eyes of second row small, closer to ALE than to the eyes of the third row.

As the name implies this genus is related to the recent Genus *Evophrys* from which it may be separated by the position of the small eyes and by the presence of lateral spines on the first and second tibia. From the recent Genus *Akela* which is closely related to *Evophrys*, the Genus *Parevophrys* may be distinguished by the relative width of the eyegroup and the spination of the second tibia. Type *P. succini*.

*Parevophrys succini*, n. sp. Plate LVI, Fig. 522, Plate I, Figs. 1 to 7.

One specimen No. C6656, in the Baltic amber collection of the Sedgwick Museum, Cambridge, England.

Holotype. Mature male. Total length 7.12 mm. Carapace (Fig. 1) 3.80 mm. long, 2.85 mm. wide between second and third coxae, 2.85 mm. wide in face view between the ventral angles (Fig. 4.) The highest point of the carapace is in the region of the thoracic groove where the elevation of the carapace over the sternum is 2.09 mm. From here on the carapace slopes in a gentle curve forward and in a steep curve backward. The thoracic groove is longitudinal, short, situated between and behind the third row of eyes. The head is flat, with a distinct depression between the eyes. The eyegroup is slightly wider behind than in front and distinctly wider than long. Width of first row 2.28 mm., of second row 1.99 mm., of third row 2.37 mm. Length of eyegroup 1.99 mm. Ratio of eyes (the so-called small eyes of the second row are the PME, the eyes of the third row are the PLE) AME: ALE: PME: PLE = 8: 4: 1.5: 4. Viewed from above the small eyes are nearer to the ALE than to the eyes of the third row in ratio 7: 10 (Fig. 3). The clypeus is low, equal to the radius of the AME and is clothed with short, white hair. A single, long, fine, median bristle is present on the clypeus just below the AME. A tuft of four long, stout bristles is present on each side of the head just outside the small eyes (Fig. 3). The base of the AME is surrounded by a crown of fine hairs. The surface of the head and thorax is shiny with a few scattered, long hairs.

The chelicerae (Fig. 4) are rather slender and distinctly concave on the inner surface. The margins are short, transverse, the pro-marginal is smooth, light in color. The retromarginal (Fig. 5) is armed with a single, stout, cone-shaped tooth of very dark color, plainly visible when the spider is examined in face view. The fangs are short, stout and strongly curved. The maxillae (Fig. 2) are considerably wider in front than at base, with rounded outer edge and a fairly dense scopula. The lip is free, longer than wide in ratio 4:3, more or less hexagonal in shape, narrower in front than at base. The sternum is flat, much longer than wide in ratio 13:8. In front it is truncated to the width of the lip. Posteriorly it is bluntly pointed in front of the fourth coxae which are contiguous. The first coxae are the largest and are separated by the width of the lip. The order of legs is presumably 4312, at least if one considers that the fourth tibia with patella is longer than the third tibia with patella. The metatarsi and tarsi of the fourth pair are missing. The fourth femur is considerably more slender than the first femur. The legs are hairy, but the hair is simple. There is a heavy brush of light brown hair on the ventral surface of the first, second and third patella and tibia, but none on the fourth patella or tibia. The spines are numerous and stout.

	Femur	Pat. + Tib.	Metat.	Tarsus	Total
I	2.20	2.80	1.20	0.80	7.00
II	2.20	2.60	1.00	0.60	6.60
III	2.37	2.60	1.20	1.00	7.17
IV	2.37	2.85	?	?	?

Width of first patella 0.628 mm. First tibial index 22.

Width of fourth patella 0.428 mm. Fourth tibial index 15.

*Spines.* First leg. Femur dorsal 1-1-3, prolateral 0-0-1, retrolateral 0, ventral 0. Patella prolateral 1, retrolateral 1, elsewhere 0. Tibia dorsal 0, prolateral 1-1-0, retrolateral 1-1-0, ventral 2-2-2, the first pair near base, the third pair apical. Metatarsus ventral 2-2, elsewhere 0.

Second leg same as first.

Third leg. Femur dorsal 1-1-3, prolateral 0-1-1, retrolateral 0-0-1, ventral 0. Patella prolateral 1, retrolateral 1, elsewhere 0. Tibia dorsal 0, prolateral 1-1-1, retrolateral 1-1-1, ventral 2-2-2. Metatarsus dorsal 0, prolateral 1-2, retrolateral 1-2, ventral 2-2,

(thus the three pairs of apical spines form a verticellum composed of 6 spines).

Fourth leg. Femur, patella and tibia same as third.

Two claws, similar (Fig. 6), with four small teeth in distal third. The claw-tufts are thick, well developed. The trichobothria are numerous and plainly visible on tibiae, metatarsi and tarsi.

The abdomen is 3.0 mm. long, 1.2 mm. wide in front, 2.0 mm. wide at the beginning of the second third, gradually narrowed posteriorly. It is sparsely clothed with long hair on the dorsal surface. This hair has the appearance of fine bristles. The ventral surface is smooth and clearly shows four rows of discs, often interpreted as attachment points of dorso-ventral muscles in recent spiders, an interpretation which has no support in reality. The spinnerets are stout and short. The anterior pair are contiguous, somewhat shorter and stouter than the posterior pair. The median spinnerets are not visible. A colulus is wanting. A circular fold surrounds the spinnerets, but is probably the result of shrinkage after death. There are no scales of any kind either on the cephalothorax or the abdomen.

The palpi are slender, with long white hair. The femur has 0-1-1 dorsal and 0-0-1 retrolateral spines, but none elsewhere. The femur is longer than the patella with the tibia, the patella is slightly longer than the tibia. The tibia has a slender retrolateral apical apophysis (Fig. 7) which is distinctly bilobed at the end. The cymbium is as long as the patella with the tibia, but wider than the latter. The embolus arises at the base of the bulb and is long, slender, curved, needle-like.

#### Subfamily *Gorgopidinae*, nov.

The chief character differentiating this subfamily from others in the division Unidentati is furnished by the structure of the chelicerae. Both margins are smooth, without any teeth, with just a few hairs for a scopula. To this character must be added the presence of a transverse depression in the carapace behind the eyes of the second row; the position of these relatively small eyes on the pedestals of the anterior lateral eyes, far from the eyes of the third row; the wide anterior truncature of the ovoid sternum; the relative length of the legs, the fourth being the longest; and finally the peculiar development of the spigots on all spinnerets.

Among recent spiders belonging to the division Unidentati the

subfamily Sitticinae as delimited in my system alone is characterized by the absence of a tooth on the retromargin. But the promargin has two or three teeth. The absence of teeth on both margins is unique in salticid spiders and makes the erection of the new subfamily imperative. Apart from this character the fossil spiders of the Genus *Gorgopsis* have many features in common with recent *Dendryphantinae*.

Genus *Gorgopsis* Menge, 1854

Type *G. frenata* (Koch and Berendt)

The genus *Gorgopsis* was proposed by Menge for four of the nine species described by Koch and Berendt under the generic name *Phidippus*, namely *P. frenatus* for which Menge proposes the name *Gorgopsis torva*; *P. melanocephalus* for which he proposes the name *Gorgopsis Lynx*; *P. marginatus* and *P. fasciatus*. Menge expresses the opinion that *P. marginatus* may be only a variety of *P. melanocephalus*, and that *P. impressus* is a young specimen probably also belonging to the same species. He further thinks that *P. paululus* and *P. pusillus* are immature females probably belonging to the species *P. frenatus*, while *P. formosus* may be a *P. fasciatus*. (*Phidippus gibberulus*, as we have already stated, according to Menge belongs to the Genus *Euophrys*). Thus Menge was able to recognize only three species, *frenatus*, *melanocephalus* and *fasciatus*. Of these species *P. frenatus* is the first among the nine species described by Koch and for this reason under the present rules of nomenclature is the Type of Menge's Genus *Gorgopsis*, because Menge himself did not specify a type. But there is no valid reason why Koch's name *frenatus* should be changed to *torva* as proposed by Menge, even if it happened to be preoccupied under the Genus *Phidippus*, which it is not. Koch referred to this species three females and two males. Their description is so inadequate that Menge tried to give differentiating characters in his footnote on page 93. Even so I am quite unable to grasp the distinctive features of the three species and believe that all three belong probably to a single species. However, this point can be settled only on reexamination of the original specimens.

Menge's definition of the Genus *Gorgopsis* as given by him in the footnote on page 93 is quite inadequate from the point of view of modern arachnology. Fortunately it is sufficient for the recogni-

tion of species as belonging to this genus. The following definition based on specimens which are described below and which I refer to the species *Gorgopsis frenata* conforms with modern requirements.

New definition of the Genus *Gorgopsis* Menge.

Both margins of chelicerae smooth. Maximum width of carapace considerably greater than width of third row of eyes. Carapace constricted between the eyes of the second and third row and transversely depressed. Eyegroup wider in front than behind, wider than long. Eyes of second row small, considerably in advance of the eyes of the third row, situated on the dorsal swollen base of the anterior lateral eyes. Carapace high, with longitudinal thoracic groove and steep posterior declivity. Pedestals of the four anterior eyes surrounded by hair. Lip free, longer than wide. Maxillae very wide in front, with curved serrula. Sternum oval, convex, longer than wide, truncated in front, pointed behind. First coxae wide apart. Order of legs and relative length of their segments variable. First tibia with three pairs of ventral spines, the first pair near base. Claw-tufts well developed. Two claws, dissimilar, proclaw with more numerous and finer teeth than retroclaw. Anterior spinnerets contiguous, stouter and shorter than the posterior ones. Colulus wanting. Integument with only simple hair, scales wanting. Type: *G. frenata* (K. & B.).

### Key to Species

1. First tibia with patella in the male longer than, in the female shorter than fourth tibia with patella. Order of legs in male 1423, in female 4132 ..... *G. frenata*.
- \* First tibia with patella equal to fourth tibia with patella in both sexes. Order of legs in male 4132, in female 4312  
*G. jucunda*.

*Gorgopsis frenata* (Koch and Berendt)

*Phidippus frenatus* Koch and Berendt, 1854, p. 88, Plate IX, Figs. 83 and 84.

1. British Museum, In. 18739, coll. Klebs 496, No. 3773.  
Mature male. *Hypotype*.
2. British Museum, In. 18753, coll. Klebs 511, No. 13432.  
Mature male. *Hypoparatype*.

3. British Museum, In. 18730, coll. Klebs 487, No. 3758. Female. *Hypogynetype*.
- 4 and 5. Two specimens in a single piece of amber. British Museum, In. 18715, coll. Klebs 473, No. 13421.
6. Specimen No. C6655 of the Sedgwick Museum, Cambridge, England. *Immature*.
7. Specimen No. 3602-C in the collection of the Peabody Museum, Yale University. *Immature*.

Description of *Hypotype*, British Museum, In. 18739. Plate LVI, Fig. 519. Plate III, Figs. 20 to 25.

A well preserved specimen in clear amber. Unfortunately the previous owner polished off the left first and left fourth legs from the middle of the tibia on; the right fourth leg across the patella, the right third leg across the tibia. The right first leg was autotomised in life and is missing. This permits complete measurements only of the second and third leg. If the specimen was nevertheless chosen by me as hypotype it is because of the excellent preservation of other important characters and complete freedom from emulsion. The structure of the palpi, clearly visible, makes it quite certain that the specimen which was chosen as hypoparatype belongs to the same species. In that specimen the third pair of legs is missing, but the first, second and fourth are complete. Thus we get a complete picture of the species by filling out the missing characters of the hypotype with characters of the hypoparatype. However, to avoid criticism the specimens are described separately. The color of the chitin is generally light brown. The abdomen stands at an angle to the cephalothorax, exposing to view the petiolus.

Total length taken as a sum of the length of the carapace and abdomen 5.4 mm. Carapace 2.44 mm. long, 1.32 mm. wide in its narrowest place just a little in front of the eyes of the third row, 1.68 mm. wide in its widest place corresponding to the posterior point of the thoracic groove. This is also the highest point of the carapace, 0.96 mm. high. The face measured between the angles is 0.88 mm. wide. The thoracic groove is longitudinal. From here on the carapace slopes forward gradually. The posterior declivity is steep.

The eyegroup (Fig. 20) is wider in front than behind, wider than long. It occupies approximately two-fifths of the carapace.

The first row of eyes is 1.36 mm. wide, the second 0.95 mm., the third 1.05 mm. The full length of the eyegroup is 1.12 mm. The four anterior eyes are on pedestals, each surrounded with a crown of hairs not well preserved. The pedestals of the AME are contiguous with each other and with the pedestals of the ALE. Ratio of eyes AME: ALE: PME: PLE = 20:8.5:3.5:8.5. The PME, *i. e.* the small eyes forming the second row, are much nearer to the ALE than to the PLE and are situated on the swollen base of the ALE. The clypeus (Fig. 21) is quite low, equal to about one-third of the radius of the AME. There are two bristles on the clypeus, one behind the other as shown in the figure, both curved backward. Between the eyes of the second and third row there is a strong, well visible, transverse depression becoming shallower as it approaches the middle of the carapace and completely disappearing not far from the mid-dorsal plane without meeting the corresponding depression of the opposite side.

The chelicerae are slender (Fig. 21), with converging outer edges, distinctly geniculated. Both margins are smooth (Fig. 24) and both have a scanty scopula composed of four hairs. The fang is weak and evenly curved. The maxillae are convex below, considerably widened in front (Fig. 22) where they are truncated. At their inner distal angle they have a small, brush-like scopula. The two maxillae are wider than the chelicerae in front and are plainly visible in face view (Fig. 21). In that position the curved serrula is also plainly visible. The lip is free, its surface almost at right angles to the surface of the sternum. It is more or less hexagonal in shape, with the front much narrower than the base and supplied with a few short hairs. It is longer than wide at base, but as long as wide in middle. The sternum (Fig. 22) is convex, oval, considerably longer than wide, with a slightly concave truncature in front, pointed behind. The first coxae are wide apart. None of the femora are thickened, nor is there any brush on the second or third leg.

	Femur	Pat. + Tib.	Metat.	Tarsus	Total
I	1.74	missing	missing	missing	?
II	1.51	1.97	1.16	0.64	5.28
III	1.39	1.62	1.29	0.64	4.94
IV	1.74	missing	missing	missing	?

Width of second patella 0.261 mm. Second tibial index 13.

Width of third patella 0.261 mm. Third tibial index 16.

*Spines.* Second leg. Femur dorsal 1-1-3, first spine near middle, prolateral 0-0-1, retrolateral 0-1-1, ventral 0. Patella dorsal 0, prolateral 1, retrolateral 1, ventral 0. Tibia dorsal 0, prolateral 1-1, retrolateral 0, ventral 1r-2-2, the first spine near base. Metatarsus ventral 2-0, elsewhere 0.

Third leg. Femur dorsal 1-1-3, first spine near middle, prolateral 0-1-1, retrolateral 0-1-1, ventral 0. Patella dorsal 0, prolateral 1, retrolateral 1, ventral 0. Tibia dorsal 0, prolateral 1-1, retrolateral 1-1, ventral 0-1p-2. Metatarsus dorsal 0, prolateral 1-1-1, retrolateral 1-1-1, ventral 2-2.

Claw-tufts well developed, dense (Fig. 23). Two claws, dissimilar, the proclaw with more numerous and finer teeth than the retroclaw. Trichobothria in two rows on tibiae, metatarsi and tarsi. The legs are clothed with simple hair.

The abdomen is elongated, ovoid, 2.96 mm. long with the spinnerets, 1.44 mm. wide, clothed with two types of simple hair. One is numerous, short, recumbent. The other is sparse, longer and more or less erect. Six cylindrical spinnerets. The anterior pair is contiguous, somewhat shorter and stouter than the posterior pair. One can plainly see the spinning tubes on all six spinnerets. The anal tubercle is cone-shaped and rather long.

The palpi are well preserved and very characteristic. The femur is 1.23 mm. long, patella with tibia 0.46 mm., cymbium 0.75 mm. The tibia is only very little longer than the patella and has an apical, hook-like, almost black apophysis (Fig. 25). The bulb is prominent. The embolus occupies the distal end of the bulb. It is fine, needle-like, curved almost in a circle and is closely applied to a curved, but stouter conductor.

*Hypoparatype.* British Museum, In. 18753. Plate LVI, Fig. 517. Plate IV, Figs. 27 and 28, Plate VI, Fig. 50.

A well preserved specimen. Both legs of third pair autotomized in life and missing. A great deal of white emulsion on the ventral surface. The color of the chitin is rufous to brown, with the legs and abdomen somewhat lighter than the carapace.

Mature male. Total length 5.04 mm. Carapace 2.68 mm. long, 1.40 mm. wide in its narrowest place between the eyes of the second and third rows, 1.88 mm. wide in its widest place between the second third coxae. The transverse depression between the



second and third rows of eyes very distinct. The first row 1.52 mm. wide, the second 1.19 mm., the third 1.21 mm. Total length of the eyegroup 1.45 mm. Ratio of eyes AME:ALE:PME:PLE = 21:12:5:12. The four eyes of the first row are on pedestals, each surrounded with a crown of hair. The thoracic groove is longitudinal, in the highest region of the carapace. The posterior declivity is steep. The carapace is clothed with hair which is coated with white emulsion. The eyes of the second row are situated much nearer to the ALE than to the PLE and on the swollen base of the former. Mouthparts and sternum too heavily coated with white emulsion for purposes of study. Legs presumably in order 1423.

Leg formula	1	4	2	3
	2.9	2.7	2.0	?

	Femur	Pat. + Tib.	Metat.	Tarsus	Total
I	1.92	3.28	1.68	0.80	7.68
II	1.60	2.00	1.20	0.60	5.40
III	?	?	?	?	?
IV	2.08	2.44	2.00	0.80	7.32

Width of first patella 0.309 mm. First tibial index 9.

Width of second patella 0.309 mm. Second tibial index 15.

Width of fourth patella 0.245 mm. Fourth tibial index 10.

*Spines.* First leg. Femur dorsal 1-1-3, prolateral 0-0-1, retrolateral 0-0-1, ventral 0. Patella 0. Tibia ventral 2-2-2, the first pair very near base, elsewhere 0. Metatarsus ventral 2-0, elsewhere 0.

Second leg. Femur dorsal 0-0-3, prolateral 0-0-1, retrolateral 0-1-1, ventral 0. Patella prolateral 1, elsewhere 0. Tibia dorsal 0, prolateral 1-1, retrolateral 0, ventral 1r-?, the 1r spine is clearly in view, but the rest of the ventral surface of this tibia is heavily coated with white emulsion. Metatarsus ventral 2-0, elsewhere ? view obstructed by white emulsion.

Fourth leg. Femur dorsal 1-1-3, prolateral 0-1-1, retrolateral 0, ventral 0. Patella prolateral 1, retrolateral 1, elsewhere 0. Tibia dorsal 1r-0-1, prolateral 1-0-1, retrolateral 1-1-1, ventral 2-2-2. Metatarsus dorsal 0, prolateral 1-1-1, retrolateral 1-1-1-1, ventral 2-2-2.

Claw-tufts well developed, dense, on a common support (Fig. 50). Two dissimilar claws, proclaw with more slender and more

numerous teeth than retroclaw. Since the claws sit directly on the tarsus, the above mentioned support of the claw-tufts cannot be regarded as an onychium.

The abdomen is 1.37 mm. long, 0.94 mm. wide, clothed with two types of simple hair. One type is short, recumbent. The other is longer, stouter and more or less erect, but less numerous. The spinnerets are barely visible through the white emulsion.

Both palpi are well visible, although coated with emulsion. The tibia has a brush of long hair on the prolateral surface (Fig. 27) and an apical hook-like apophysis. The embolus is situated at the end of the bulb, forming almost a complete ring in a plane transverse to the longitudinal axis of the palp (Fig. 28). It is closely applied to the conductor which is much stouter and shorter, yet quite pointed.

*Hypogynetype*. British Museum, In. 18730. Plate LVI, Fig. 520.

Female, presumably mature, but the abdomen is so heavily coated with white emulsion that the epigynum cannot be seen. However, the region of the epigynum is raised as a semiglobular area, making it probable that the epigynum is not visible only because of the heavy coating with white emulsion. The dorsal surface is clear. The color of the chitin is reddish brown. The left fourth leg was autotomized in life and is missing. Otherwise the specimen is very well preserved and closely resembles the male.

Total length 5.9 mm. Carapace 2.96 mm. long, 2.12 mm. wide between second and third coxae where it is widest, 1.20 mm. high in the region of the thoracic groove. Sides and posterior declivity steep. The thoracic groove is line-like, longitudinal, far behind the eyegroup. The top of the head is flat, but there is a deep transverse depression on each side between the eyes of the second and third row.

The eyegroup is slightly wider than long in ratio 40:38. The first row of eyes is 1.60 mm. wide, the second 1.28 mm., the third 1.28 mm. The first row is slightly recurved and projects beyond the clypeus and the ALE project beyond the lateral margins of the carapace. The PME are far from the lateral margins. The ratio of the eyes AME:ALE:PME:PLE = 25:11:2.5:10. The four eyes of the first row are contiguous. The eyes of the second row are situated on the swollen bases of the ALE, far in advance

of the PLE. The ratio of the distance between the ALE and the PME to that between the latter and the PLE is 13:35. The clypeus is equal to half the radius of the AME. The carapace is clothed with long, brown, recumbent hair directed forward and inward, and with long, more or less erect brown bristles. The pedestal of the AME is surrounded by a crown of brown hair. The crowns around the ALE have been partly lost.

Chelicerae, mouthparts and sternum cannot be seen on account of the heavy coating with emulsion. The first coxae are far apart, the fourth coxae are approximated. The legs are stout, comparatively short, with stout spines.

Leg formula	4	1	3	2
	2.2	1.7	1.7	1.6

	Femur	Pat. + Tib.	Metat.	Tarsus	Total
I	1.60	2.00	1.00	0.56	5.16
II	1.40	1.92	0.96	0.56	4.84
III	1.52	1.68	1.20	0.56	4.96
IV	2.00	2.40	1.60	0.56	6.56

Width of first patella 0.355 mm. First tibial index 18.

The figure for the third tarsus is assumed to be correct. Measurement is impossible on account of emulsion.

The fourth patella cannot be measured. The legs are distinctly hairy. There is a prolateral scopula on the first tarsus and metatarsus, none on the other legs.

*Spines.* First leg. Femur dorsal 1-1-3, prolateral 0-0-1, retrolateral 0-0-1, ventral 0. Patella 0. Tibia ventral 2-2-2, the first pair close to base, elsewhere 0. Metatarsus ventral 2-0, elsewhere 0.

Second leg same as first.

Third leg. Femur dorsal 1-1-3, prolateral 0-0-1, retrolateral 0-0-1, ventral 0. Patella prolateral 1, retrolateral 1, elsewhere 0. Tibia dorsal 1-0, prolateral 1-1, retrolateral 1-1, ventral ? (view obstructed by emulsion). Metatarsus dorsal 0, prolateral 1-1-2, retrolateral 1-1-2, ventral 2-2-2 (the six apical spines forming a verticellum).

Fourth leg. Femur dorsal 1-1-3, prolateral 0-0-1, retrolateral 0-0-1, ventral 0. Patella prolateral 1, retrolateral 1, elsewhere 0. Tibia dorsal 1-0-1, prolateral 1-1-1, retrolateral 1-1-1, ventral 1-0-1. Metatarsus dorsal 1-0, prolateral 1-1-2, retrolateral 1-1-2, ventral 2-2-2 (the six apical spines forming a verticellum).

The claw-tufts are well developed, composed of two tufts of tenent hairs. Two dissimilar claws. The proclaw with a long series of teeth, the retroclaw with seven teeth. Trichobothria not visible.

The abdomen is elongated, truncated in front, pointed behind, 3.2 mm. long, 1.8 mm. wide. It is transversely wrinkled and on the sides with longitudinal plications. It is thickly clothed with long recumbent hair and with brown bristles which stand at all angles and give the abdomen a hairy appearance. The anal tubercle is long, cone-shaped, two-jointed, hairy. The spinnerets are heavily coated with emulsion. The palpi are of the female type. They are also heavily coated, but some spines can be seen through the emulsion.

*Specimens* In. 18715 of the British Museum undoubtedly belong to this species. One of the specimens is a mature male and the palpi can be seen sufficiently to show the tibial apophysis. The other specimen is apparently a male in the penultimate instar. Both specimens closely resemble the male specimens described above in every detail that can be seen. The spinnerets are plainly visible.

*Description of the immature specimen No. C6655* in the collection of the Sedgwick Museum, Cambridge. Plate LVI, Fig. 521, Plate II, Figs. 8 to 11.

It is a well preserved specimen in clear amber. The second left leg was autotomized in life and is missing. Scattered through the amber close to the spider are some of its hairs evidently lost while the creature was trying to get out of the gum. The color of the chitin is uniform dark rufous. Total length 2.2 mm. Carapace (Fig. 8) 1.12 mm. long, 0.56 mm. wide in the narrowest place between the eyes of the second and third row, 0.68 mm. wide in the region of the eyes of the third row. The head is flat above, but with deep transverse depressions on each side between the eyes of the second and third row. Posterior declivity steep.

First row of eyes 0.72 mm. wide, second row 0.60 mm., third row 0.60 mm. Length of eyegroup 0.64 mm., i. e. the eyegroup is wider than long in ratio 9:8. Ratio of eyes AME:ALE: PME:PLE = 20:6:1:6. The ratio of the distance between ALE and PME to that between the latter and PLE is 4:9. The clypeus is quite narrow. The carapace is free of all hair.

The chelicerae are small, stout. The lip is free, rectangular

(Fig. 9) wider than long in ratio 7:3.5. The maxillae are much wider in front than at base, their inner edges are converging, but do not meet. The sternum is wide in front, convex, oval, longer than wide in ratio 9:7. First coxae wide apart. Fourth coxae are separated by about their width. Legs fairly stout, clothed with short hair.

Leg formula	4	1	2	3
	1.6	1.3	1.3	1.1

	Femur	Pat + Tib.	Metat.	Tarsus	Total
I	0.43	0.56	0.26	0.26	1.51
II	0.41	0.48	0.26	0.26	1.41
III	0.43	0.29	0.26	0.26	1.24
IV	0.52	0.67	0.36	0.26	1.81

The spines are partly lost and their disposition cannot be ascertained, because the little base on which a spine sits cannot be seen in the amber spiders except under unusual conditions. One can say that spines are present on femora, tibiae and metatarsi. On the femora the dorsal row of spines is visible. Some ventral spines can be seen on the anterior tibia and metatarsus and at least one prolateral spine on the posterior tibia. The trichobothria are not visible. Two claws, dissimilar (Fig. 10). Proclaw with a long series of slender, equally long teeth. Retroclaw with about half the number of teeth which are much shorter, stouter and bluntly rounded at the end. The claw-tufts are well developed, but are formed not by tenent hairs, but by simple, fine hairs.

The abdomen is ovoid, narrower behind than in front, slightly overlapping the carapace, 1.0 mm. long, 0.64 mm. wide. The spinnerets are cylindrical. The anterior pair are contiguous, slightly shorter than the posterior pair. On the terminal joint of the latter several spigots are visible (Fig. 11). A colulus is wanting.

*Immature specimen* No. 3602-C in the collection of the Peabody Museum, Yale University. It is a complete and well preserved specimen. Some white emulsion appears on the right side and on the mouthparts. The color of the chitin is almost yellow.

Total length 2.5 mm. Carapace 1.2 mm. long, 0.8 mm. wide between second and third coxae. First row of eyes 0.74 mm. wide, second row 0.60 mm., third row 0.60 mm. Length of eyegroup 0.67 mm. Ratio of eyes AME:ALE:PME:PLE=11:6:2.5:6. The eyes of the second row are situated far in advance of the eyes

of the third row, on the swollen base of the ALE. The thoracic groove is longitudinal, deep. Posterior declivity steep. Lip slightly wider than long, with rounded sides. Sternum oval, longer than wide, pointed behind. First coxae wide apart. Fourth coxae separated by half their width.

Measurements of only two legs are given here for comparison.

	Femur	Pat. + Tib.	Metat.	Tarsus	Total
I	0.55	0.65	0.31	0.29	1.80
IV	0.77	0.77	0.48	0.33	2.35

The order of the legs is 4123.

The abdomen is 1.25 mm. long, 0.76 mm. wide. The spinnerets are cylindrical, clearly visible. Of the same structure as in the specimens described above.

#### Remarks concerning the species *Gorgopis frenata*

There is a discrepancy in measurements of the eyes and legs in the specimens described above. Some of these discrepancies are due to shrinkage and distortion. Other discrepancies may be due to differences of age and sex. Many years ago I have shown by measurements that the relative size and disposition of eyes changes with age. Similar changes always affect the relative proportions of the carapace. In the case of fossil specimens one has always to consider the possibility that the specimens under consideration may belong to different species. I think this possibility is ruled out in the case of the specimens described above. They look too much alike to permit their separation into two or more species. Instead of simplifying the case the separation of like specimens would require an explanation of their unquestionable similarity.

#### *Gorgopis jucunda*, n. sp.

1. Type. Mature female. British Museum, In. 18758, coll. Klebs 516, No. 3765. Plate LXVIII, Fig. 608. Plate VI, Figs. 48 and 49.
2. Immature male. British Museum, In. 18747, coll. Klebs 505, No. 3768. Plate LXVIII, Figs. 609 and 610.
3. Immature male. British Museum, In. 18763, coll. Klebs 521, No. 13464. Plate III, Fig. 26.
4. Immature female. British Museum, In. 18735, coll. Klebs 492, No. 13480. Plate LVI, Fig. 518. Plate IV, Figs. 29 to 32.

5. Immature female. British Museum, collection from Samland, In. 18112.
6. Exuvium, partially decomposed and very poorly preserved. British Museum, collection from Samland, In. 18949.

This species has much in common with the preceding one. At first I was even inclined to regard the specimens assembled here under the name of *G. jucunda* as atypical representatives of *G. frenata*. As usual, I made the individual descriptions without at once comparing them with others already described. Only careful study of all notes and comparison of various characters revealed the existence of differences. The specimens were then assorted in accordance with their characters. When this was done it became apparent that even differences in general appearance existed. While the total length of the adult females, for example, is nearly the same—*G. frenata* is 5.9 mm. long, *G. jucunda* 5.8 mm.—the carapace of the former is appreciably larger, being 2.96 mm. long and 2.12 mm. wide as against 2.20 by 1.5 mm. in the latter. The difference in the absolute length of the legs is also quite appreciable. In the above specimen of *G. frenata* they are in the natural sequence 5.16, 4.84, 4.96 and 6.56 mm., while in *G. jucunda* 3.82, 3.70, 3.87 and 4.64. The order of legs is also different. These differences give *G. frenata* a more robust appearance. Were it possible to compare the palpi and epigyna, all possible doubt could be eliminated. Unfortunately the specimens of *G. jucunda* of the male sex are immature, while in the case of the female of *G. frenata* the genital area is too heavily coated with white emulsion to permit a study of the epigynum. Nevertheless I believe the differences pointed out above are not only sufficient for the separation of the species, but make such separation imperative.

*Description of the Type.* British Museum, In. 18758. Plate LXVIII, Fig. 608, Plate VI, Figs. 48 and 49.

Mature female in perfectly clear amber, except for a little emulsion on the mouthparts. The second left leg was autotomized in life and is missing. Otherwise the specimen is complete. The color of the chitin is light rufous, with the spines still lighter in color.

Total length 5.8 mm. Carapace 2.2 mm. long, 1.5 mm. wide

between second and third coxae where it is widest, 0.7 mm. high in the region of the thoracic groove. The posterior declivity is steep. The carapace appears high and the thoracic groove is long, line-like, situated considerably behind the eyes of the third row (Fig. 48). The top of the head is flat, but there is a deep, transverse depression on each side behind the eyes of the second row (Fig. 49). The first row of eyes occupies the entire width of the head, projecting beyond its sides. The width of the first row is 1.28 mm., of the second row 1.04 mm., of the third row 1.00 mm. The eyegroup is wider than long in ratio 52:46. Ratio of eyes  $AME:ALE:PME:PLE = 20:9:3:9$ . The eyes of the second row are situated on the swollen bases of the ALE, far in advance of the PLE. The ratio of the distance between the ALE and PME to that between the latter and the PLE is 10:28. The AME are directed almost straight forward, the ALE forward and outward, the PLE slightly upward and outward, almost at right angles to the transverse plane of the carapace. The clypeus is about equal to one-tenth of the diameter of AME which project considerably beyond it. The face is rather peculiar in appearance owing to the large size of the AME (Fig. 49), which make the head look high. The sides of the head under the ALE are vertical, but are steeply inclined under the PLE. The AME are contiguous, but are separated from the ALE by one-tenth of the diameter of the AME. The distance between the eyes of the third row is equal to four of their diameters.

The chelicerae are vertical, converging. Their basal joint is 0.9 mm. long. The margins and fangs cannot be seen. The maxillae are parallel and the palp is inserted at their base. The lip is about as long as wide, rounded at the end. The sternum is slightly convex, longer than wide, truncated in front, pointed behind. The first coxae are wide apart, the fourth coxae are contiguous.

Leg formula	4	3	1	2
	2.1	1.8	1.7	1.7

	Femur	Pat. + Tib.	Metat.	Tarsus	Total
I	1.08	1.54	0.74	0.46	3.82
II	1.08	1.42	0.74	0.46	3.70
III	1.15	1.32	0.94	0.46	3.87
IV	1.44	1.54	1.20	0.46	4.64

Width of first patella 0.264 mm. First tibial index 17.

Width of fourth patella 0.264 mm. Fourth tibial index 17.



*Spines.* First leg. Femur dorsal 1-1-3, prolateral 0-0-1, retrolateral 0-0-1, ventral 0. Patella 0. Tibia ventral 2-2-2, the first pair near base, the third apical, elsewhere 0. Metatarsus ventral 2-0 long spines near base, elsewhere 0.

Second leg same as first except tibia prolateral 1-1.

Third leg. Femur dorsal 1-1-3, prolateral 0-0-1, retrolateral 0-0-1, ventral 0. Patella prolateral 1, retrolateral 1, elsewhere 0. Tibia dorsal 1-0, prolateral 1-1, retrolateral 1-1, ventral 0-2-2. Metatarsus dorsal 1-0-1, prolateral 1-1-1, retrolateral 1-1-1, ventral 2-0-2 (the five apical spines forming a verticellum).

Fourth leg same as third except tibia dorsal 1-1, ventral 2-2-2. Claw-tufts well developed, composed of two groups of tenent hairs. Two claws, dissimilar, proclaw with a long series of teeth, retroclaw with about six teeth. The legs are clothed with simple hair of two types. The one is much shorter than the other which is almost erect and has the appearance almost of bristles. Trichobothria cannot be seen.

The abdomen is ovoid, more or less pointed behind, slightly flattened above, 3.8 mm. long, 2.2 mm. wide. It is clothed with long, recumbent hair directed backwards. On the sides more or less curly hair is present. This may be due to deformation, but since elsewhere the hair is straight it seems probable that the curling is natural. Six spinnerets, cylindrical, long. Two threads of silk are still attached to one of the spinnerets. The anterior spinnerets are contiguous, stouter and longer than the posterior ones. The latter are separated by the width of the anal tubercle. On the terminal joint of the left posterior spinneret at least three common spinning tubes are visible under high power. This joint is rounded and much shorter than the basal joint. A colulus is wanting.

On the ventral surface of the abdomen an elliptical area is visible between the hind coxae. It is longer than wide and undoubtedly represents the epigynum. No detail can be seen. The entire abdomen is coated with a semitranslucent sheath of emulsion.

The palpi are of the female type. The tibia has 1-1 dorsal spines and several spines are present on the terminal joint. This joint is as long as the tibia and patella together. No palpal claw can be seen, but the view of the palpal end is not clear.

There are no scopulae on any tarsi or metatarsi.

2. *Immature male. British Museum, In. 18747. Plate LXVIII, Figs. 609 and 610.*

This is a poorly preserved specimen which fell apart when it was removed from the original mount and placed into cedar oil for examination. In a way this was fortunate because pieces of the chitin separated from the amber and were mounted on slides in balsam. One piece comprised the lip, maxillae, sternum and coxae. Another piece represented a tarsus. Mounted they permitted examination under very high power.

Total length with spinnerets 4.12 mm. Carapace 1.8 mm. long, 1.16 mm. wide between second and third coxae where it is widest. First row of eyes 1.00 mm. wide, third row 0.80 mm. Length of eyegroup 0.88 mm. Eyes of second row situated on the swollen bases of the ALE. Ratio of distance between ALE and PME to that between the latter and the PLE 6:34. Ratio of eyes AME:ALE:PME:PLE = 17:7:2:7. AME contiguous with each other and subcontiguous with the ALE. Transverse depression behind the eyes of the second row on each side of the head. The pedestals of the four anterior eyes are clearly visible. The carapace is high, with a longitudinal thoracic groove and steep posterior declivity.

The lip is free, with rounded end. The maxillae (Fig. 609) with a dense scopula along their entire inner edge and a tuft of longer hair at the beginning of the serrula. The latter (Fig. 610) is straight and fairly long. The sternum is flat, longer than wide, truncated in front not quite to the combined width of the maxillae and lip, pointed behind. The first coxae are wide apart. The fourth coxae are separated by half their width.

Leg formula	4	1	3	2
	2.2	1.9	1.8	1.7

	Femur	Pat. + Tib.	Metat.	Tarsus	Total
I	1.00	1.32	0.60	0.52	3.44
II	0.92	1.08	0.52	0.52	3.04
III	0.96	1.00	0.64	0.52	3.12
IV	1.20	1.32	1.00	0.52	4.04

*Spines.* First leg. Femur dorsal 1-1-2, prolateral 0-0-1, retrolateral 0-0-1, ventral 0. Patella 0. Tibia ventral 2-2-2, elsewhere 0. Metatarsus ventral 2-0, elsewhere 0.

Second leg same as first.

Third leg. Femur dorsal 0-0-1, prolateral 0-0-1, retrolateral 0-0-1, ventral 0. Patella prolateral 1, retrolateral 1, elsewhere 0. Tibia dorsal 1-0, prolateral ?, retrolateral 1-1, ventral ?. Metatarsus retrolateral 1-1, elsewhere ?.

Fourth leg. Femur dorsal 1-1-1, prolateral 0-0-1, retrolateral 0-0-1, ventral 0. Patella prolateral 1, retrolateral 1, elsewhere 0. Tibia dorsal 1-0-1, prolateral ?, retrolateral 1-1-1, ventral ?. Metatarsus dorsal 1-1, prolateral 1-1, retrolateral 1-1, ventral ?.

Scopulae wanting on all legs. Claw-tufts well developed. Two claws, dissimilar. Palpi with swollen cymbium showing that it is a male in the penultimate instar.

Abdomen ovoid, 2.2 mm. long to base of spinnerets, 1.4 mm. wide. Six spinnerets, cylindrical. Anterior pair somewhat shorter than posterior pair. Median pair slender and small. A colulus is wanting.

Integument of body and legs clothed only with simple hair.

3. *Immature male. British Museum, In. 18763. Plate III, Fig. 26.*

This is a poorly preserved specimen which split into two pieces when removed from its original mount. Apparently it was cemented together by the original owner. To avoid further damage the dorsal half was mounted on a separate slide from the ventral one. This cleared the amber considerably and made better study possible.

Total length with spinnerets 2.4 mm. Length of carapace 1.08 mm. The palpi are with swollen cymbium showing that the male was in the penultimate instar. The spinnerets are figured in Fig. 26 and show that the anterior pair are both stouter and shorter than the posterior pair. The anal tubercle is three-jointed and covered with hair on its back. All other characters are as far as they are visible as in the preceding specimen.

#### Division *Pluridentati*

#### Subfamily *Boethinae*

Among recent jumping spiders this subfamily includes all species with fairly large eyes of the second row. It is a peculiar group of ten genera found only in the East from eastern Africa to Indo-

Malaysia. The only character which could be interpreted as evidence of origin from a more primitive stock than all other *Salticidae* is furnished by the eyes of the second row, which are, indeed, much larger than usual for the family. It was Menge who first recognized the existence in the Baltic amber of jumping spiders with large eyes of the second row. He proposed for them the generic name *Propetes*. As I have explained above Menge failed to describe a single of the several species which he listed under the Genus *Propetes*. His species are therefore nomina nuda. The generic name *Propetes* is preoccupied and cannot be used for spiders. Three new genera, *Eolinus*, *Paralinus* and *Cenattus*, are placed here in the Subfamily *Boethinae*. It is impossible to say which of these genera corresponds to Menge's *Propetes*. They may be distinguished as follows:

1. All eyes on high pedestals. Eyes of second row three times smaller than anterior median eyes. Width of third row of eyes greater than width of head. . . . . *Cenattus*.
- \* Anterior four eyes on low pedestals, the other four eyes not elevated. Eyes of second row about half as large as the anterior median eyes. Width of third row of eyes smaller than width of head . . . . . 2
2. Tibiae with at least two dorsal spines. Order of legs 4312. Proclaw with five or six teeth, retroclaw with four teeth . . . . . *Paralinus*.
- \* At least first tibia without dorsal spines. Order of legs 4132. Proclaw with from eight to 14 teeth. . . . . *Eolinus*.

#### Genus *Eolinus*, nov.

Carapace high, wider than third row of eyes. Eyegroup wider than long. Eyes of second row about half as large as the AME and situated about half way between the ALE and the eyes of the third row. Clypeus quite low. Chelicerae with oblique margins. Promargin smooth. Retromargin with four teeth. Sternum longer than wide. First coxae wide apart. Order of legs 4132. First tibia without dorsal spines, with three pairs of ventral spines the first of which is close to base. Two claws, similar or slightly dissimilar. Claw-tufts well developed. Six cylindrical spinnerets. Type *E. succineus*.

Key to Species of *Eolinus*

1. Fourth tibia with 0-0-2, ventral spines in the female, 0-0-1 ventral spine in the male. Eyes of second row half way between ALE and PLE. Tibial apophysis of male palp finger-like, curved backwards. . . . . *E. succineus*.
- \* Fourth tibia with 1p-1p-2 ventral spines. Eyes of second row slightly nearer to the ALE. Tibial apophysis of male palp with two pointed hooks directed forwards. . . . *E. theryi*.

*Eolinus succineus*, n. sp.

1. Type. Mature female. British Museum, In. 18762, coll. Klebs 520, No. 13478. Plate LVI, Fig. 524. Plate V, Figs. 37 to 41.
2. Androtype. Mature male. British Museum, In. 29126—A. Collection A. Théry. Plate LVI, Fig. 525. Plate V, Figs. 42 to 44.
3. Mature female. British Museum, In. 29126—B. Collection A. Théry.
4. Mature male. British Museum, In. 18732, coll. Klebs 489, No. 3782 (A badly damaged specimen).
5. Immature specimen. British Museum collection from Samland, In. 18143.

*Description of Type.* British Museum, In. 18762. Plate LVI, Fig. 524. Plate V, Figs. 37 to 41. A complete and well preserved specimen in clear amber with a little white emulsion on the ventral surface. The color of the chitin is generally brown with sternum and coxae darker than the legs.

Total length 3.64 mm. Carapace 1.68 mm. long, 1.20 mm. wide; high, with short and steep posterior declivity. Its highest point is in the plane of the eyes of the third row (Fig. 38). From here it slopes backward gently until it reaches the posterior declivity. The thoracic groove cannot be seen. Width of the first row of eyes 1.19 mm., of the second 1.07 mm., of the third 1.15 mm. The third row is, therefore, not quite as wide as the head. The length of the eyegroup is 0.90 mm. *i. e.* the eyegroup is appreciably wider than long. All eyes are prominent. The eyes of the first row are contiguous, situated on low pedestals. Ratio of eyes AME: ALE: PME: PLE = 16: 10: 7: 9. The eyes of the second

row are situated behind and a little above the ALE. They are practically half way between the ALE and the PLE. Viewed from in front (Fig. 39) the eyes of the first row are straight by their centers. The clypeus is quite low, not more than a quarter of the radius of the AME. There are a few long hairs around the eyes and on each side of the eyegroup. The carapace is sparsely clothed with very short, recumbent hair directed forward and inward.

The chelicerae are completely hidden from view by white emulsion. The maxillae are also coated with emulsion, but one can see plainly that they widen anteriorly and have a long scopula of brown hair along their inner edge. The sternum is longer than wide in ratio 9:7, fairly flat, widest between the second and third coxae, pointed behind. First coxae wide apart. Fourth coxae separated by two-thirds of their width. The sternum is clothed with short hair.

Leg formula	4	1	3	2
	1.9	1.5	1.3	1.2

	Femur	Pat. + Tib.	Metat.	Tarsus	Total
I	0.88	0.90	0.50	0.26	2.54
II	0.76	0.78	0.43	0.26	2.03
III	0.78	0.81	0.45	0.28	2.12
IV	1.04	1.12	0.71	0.30	3.17

Width of the first patella 0.190 mm. First tibial index 21.

Width of the fourth patella 0.180 mm. Fourth tibial index 16.

First and second femora convex on the dorsal surface. First patella slightly shorter than first tibia, second patella slightly longer than second tibia, third patella slightly shorter than third tibia, fourth patella equal to about three-fifths of the fourth tibia. None of the legs are in any way modified. They are clothed with simple hair which does not give them a "hairy" appearance. Trichobothria are present on tibiae, metatarsi and tarsi.

*Spines.* First leg. Femur dorsal 1-1-1, prolateral 0-0-1, elsewhere 0. Patella 0. Tibia ventral 2-2-2, the first pair near base, elsewhere 0. Metatarsus ventral 2-2, elsewhere 0.

Second leg same as first.

Third leg. Femur dorsal 1-1-1, elsewhere 0. Patella retrolateral 1, elsewhere 0. Tibia dorsal 0, prolateral 1-1, retrolateral 1-1, ventral 0-0-2. Metatarsus dorsal 0, prolateral 1-1, retrolateral 1-1, ventral 0-2.

Fourth leg. Femur dorsal 1-1-1, retrolateral 0-0-1, elsewhere 0. Patella prolateral 1, retrolateral 1, elsewhere 0. Tibia retrolateral 1-1, ventral 0-0-2, elsewhere 0. Metatarsus dorsal 0, prolateral 1-1, retrolateral 1-1, ventral 0-2.

Two claws, similar, curved, with a row of fine teeth. Claw-tufts well developed, composed of a few tenent hairs (Fig. 40).

The abdomen is 2.20 mm. long with the spinnerets, 1.28 mm. wide, ovoid, somewhat flattened above, clothed with long, brown hair on the back, with much shorter hair on the ventral surface. Six cylindrical spinnerets. Anterior pair separated by almost their width. Posterior pair slightly longer and more slender than anterior pair. The median pair cannot be seen. The anal tubercle is cone-shaped, prominent. The epigynum (Fig. 41) is elliptic, dark, with a deep posterior notch.

The patella of the palp is shorter than the tibia. The terminal joint has no claw.

No scales are found on any part of the body or legs.

*Description of Androtype.* British Museum, In. 29126—A. Plate LVI, Fig. 525. Plate V, Figs. 42 to 44. A well preserved and complete specimen in clear amber. The palpi are flexed, obstructing the view of the chelicerae.

Total length 2.96 mm. Carapace 1.56 mm. long, 1.14 mm. wide behind the eyes of the third row. The thoracic groove is not visible. The posterior declivity is steep (Fig. 44). Width of the first row of eyes 1.24 mm., of the second 1.07, of the third 1.12, *i. e.* the third row is almost, but not quite as wide as the head. Length of eyegroup 0.81 mm., *i. e.* two-thirds that of the width. Ratio of eyes AME:ALE:PME:PLE = 16:10:7:7.5. The eyes of the second row are behind and above the ALE, about half way between the ALE and the PLE. The eyes of the first row are contiguous, on short pedestals, surrounded by a crown of hair. The clypeus is very low, equal to about one half of the radius of the AME. Viewed from in front the first row of eyes is very gently curved upwards. The carapace is clothed with recumbent short hair directed forward on its back and upward on its sides. There are a few stout bristles on the sides.

The chelicerae are weak and slender, set considerably behind the anterior eyes. The margins cannot be seen clearly, but one can see a sparse scopula on the promargin. The fangs are evenly curved,

long and slender. The maxillae are convex below, with truncated anterior edge. They are wider in front than at the base, and have a weak scopula. The lip is free, much wider than long, with pro-curved suture. The sternum is convex, with concave suture for the reception of the lip. It is longer than wide in ratio 14:10 and is pointed behind. The first coxae are wide apart. The fourth coxae are contiguous. The sternum is clothed with simple hair.

Leg formula	4	1	3	2
	2.2	1.9	1.8	1.8

	Femur	Pat + Tib.	Metat.	Tarsus	Total
I	0.85	1.14	0.73	0.31	3.03
II	0.82	1.02	0.62	0.28	2.74
III	0.89	1.00	0.64	0.33	2.86
IV	1.14	1.14	0.83	0.35	3.46

None of the legs is in any way modified.

*Spines.* First leg. Femur dorsal 1-1-1, prolateral 0-0-1, retrolateral 0-0-1, ventral 0. Patella dorsal 1 apical bristle, prolateral 1, retrolateral 1, ventral 0. Tibia dorsal 0, prolateral 0-1, retrolateral 0-1, ventral 2-2-2, the first pair near base. Metatarsus dorsal 0, prolateral 1-1, retrolateral 1-1, ventral 2-2 (the four apical spines form a verticillum).

Second leg same as first, except tibia prolateral 1-1, retrolateral 1-1, ventral 0.

Third leg. Femur dorsal 1-1-1, prolateral 0-0-1, retrolateral 0-0-1, ventral 0. Patella dorsal 1-1 (the first a spine near middle, the second an apical bristle), prolateral 1, retrolateral 1, ventral 0. Tibia dorsal 1-0, prolateral 0-1, retrolateral 0-1, ventral 0-1. Metatarsus dorsal 1-1, prolateral 1-0, retrolateral 1-0, ventral 0-1.

Fourth leg same as third, except tibia prolateral 1-1, retrolateral 1-1. Metatarsus prolateral 1-1-1, retrolateral 0, ventral 0-0-1.

Trichobothria present on tibiae, metatarsi and tarsi. Two claws, similar, with a row of slender teeth. The claws are strongly curved. There are between 12 and 14 teeth, but the exact number is difficult to count. The claw-tufts are well developed, composed of numerous tenent hairs.

The abdomen is 1.56 mm. long with the spinnerets, 0.96 mm. wide one-quarter from anterior end. It tapers gradually toward the posterior end and is clothed with recumbent hair and with more or less erect long bristles. Six spinnerets, cylindrical,



Anterior pair contiguous, with hemispherical terminal joint. Posterior spinnerets more slender and longer, with cone-shaped terminal joint. Median pair slender and shorter than anterior pair. A colulus is wanting. The anal tubercle is large, cone-shaped.

The palp shows many characteristic features. Its femur is 0.50 mm. long, patella 0.21 mm., tibia 0.24 mm., cymbium 0.52 mm. The tibia (Figs. 42 and 43) is very wide at the end owing to the presence of a considerable apophysis which is finger-like and curved backwards. The cymbium is very convex. The structure of the copulatory apparatus is represented in Fig. 42.

*Eolinus theryi*, n. sp.

1. Type. Mature male. British Museum, In. 29169, coll. A. Théry. Plate LVII, Fig. 526. Plate V, Figs. 45 to 47.
2. Mature male. Peabody Museum, Yale University. Plate XLIX, Figs. 456 to 460.
3. Immature male. Specimen presented by Th. S. Painter and given by me to the Peabody Museum, Yale University. Plate LVII, Fig. 528. Plate VI, Fig. 51.

*Description of Type.* British Museum, In. 29169. The specimen is in a piece of amber showing many planes of cleavage. The abdomen is displaced to the left more than 90° so that the petiolus is exposed to view. Many important structures cannot be seen, but the palpi are well visible. The color of the chitin is dark brown.

Total length taken as sum of two measurements 4.1 mm. Carapace 1.8 mm. long, 1.36 mm. wide, 0.72 mm. high. Posterior declivity steep (Fig. 47). Anteriorly the carapace slopes gradually. It is flat between the eyes of the third row. Width of first row of eyes 1.12 mm., of second row 1.00 mm., of third row 1.04 mm. Length of eyegroup 0.92 mm. (Fig. 45), *i. e.* the eyegroup is distinctly wider than long. The eyes of the first row are contiguous, elevated on low pedestals, surrounded by a crown of hair. Ratio of eyes AME: ALE: PME: PLE = 16:9:7:8. The eyes of the second row are situated behind and above the ALE, slightly nearer to the latter than to the PLE. The width of the head is greater than that of the third row of eyes. The clypeus cannot be seen because of the position of the palpi. There are several bristles on

the clypeus. The carapace is clothed with recumbent hair and scattered erect bristles.

The chelicerae are fairly stout, with outer edges slightly converging. The armature is not visible, but one can see a scopula on the promargin. The fangs are strong, evenly curved. The maxillae are convex below, much wider in front than at the base, truncated. A scopula extends in front of the lip along the inner margin and a serrula is clearly visible. The lip is free, convex, much narrower than the truncature of the sternum, wider in middle than at the ends. The sternum is widest between the first and second coxae. Its anterior truncature is concave. Posteriorly the sternum is pointed between the hind coxae which are slightly separated. The sternum is slightly convex, longer than wide in ratio 29:23, sparsely clothed with hair. The first coxae are wide apart. None of the legs are modified.

Leg formula	4	1	3	2
	1.9	1.6	1.4	1.4

	Femur	Pat. + Tib.	Metat.	Tarsus	Total
I	0.88	1.00	0.52	0.35	2.75
II	0.84	0.88	0.52	0.35	2.59
III	0.84	0.88	0.52	0.35	2.59
IV	0.95	1.21	0.81	0.42	3.39

*Spines.* First leg. Femur dorsal 1-1-1 (the first spine in middle), prolateral 0-0-1, elsewhere 0. Patella 0. Tibia prolateral 0-0-1, ventral 2-2-2, elsewhere 0. Metatarsus prolateral 0-1, ventral 2-2, elsewhere 0.

Second leg same as first.

Third leg. Femur dorsal 1-1-1 (the first spine in middle), prolateral 0-0-1, elsewhere 0. Patella prolateral 1, elsewhere 0. Tibia dorsal 0, prolateral 1-0, retrolateral 0-1, ventral 2-2-2. Metatarsus dorsal 1-1, prolateral 1-1, retrolateral 0-1, ventral 0-2 (the five apical spines forming a verticellum).

Fourth leg same as third except tibia prolateral 0-1.

Trichobothria numerous on tibiae and metatarsi and presumably also on tarsi, but the view of the latter is partly obstructed. The claw-tufts are composed of comparatively few, but typical tenent hairs. Two, slightly dissimilar claws with a row of 8 or 9 teeth.

The legs are clothed with hair similar to that on the carapace.

The abdomen is ellipsoidal, slightly flattened above, 2.3 mm. long,

1.5 mm. wide, clothed with recumbent, light colored hair and more sparsely with slender, dark bristles. Of the spinnerets only one posterior spinneret is visible. It is cylindrical, two jointed and rather slender. The view of the other spinnerets is obstructed by white emulsion.

The palpi (Fig. 46) are very similar to those of the preceding species. The best distinction is furnished by the tibial apophyses which are pointed and directed forward. The embolus appears as a needle and there is a hook-like sclerite near the base of the bulb.

2. Description of the mature male in the collection of the Peabody Museum, Yale University. Plate XLIX, Figs. 456 to 460. Owing to an unfortunate accident the specimen was broken into three pieces *after* the following description and figures were made. The pieces were mounted on separate slides, but some of the structures cannot be seen any more. At present slide No. 1 contains the right half of the dorsal mould of the carapace, dorsal half of the abdomen with the spinnerets and the right legs of which only the first is complete. Slide No. 2 contains the left dorsal mould and legs of which only the third remains complete. Slide No. 3 contains the major portion of the chitinous carapace.

Before the accident the specimen was in a piece of fairly dark amber and occupied a place close to the surface. Two of its right tarsi were missing. There were several planes of cleavage. The color of the chitin is brown.

Total length including spinnerets 4.2 mm. Carapace 2.0 mm. long, 1.7 mm. wide between second and third coxae where it is widest, 1.0 mm. high, with steep posterior declivity, but sloping downward anteriorly in a gentle curve. The eyegroup (Fig 456) is with almost parallel sides and is narrower than the head. It is wider than long in ratio 32:25. Ratio of the eyes AME:ALE:PME:PLE = 17:11:8:9. The eyes of the second row are slightly nearer to the ALE than to the PLE. The chelicerae are stout (Fig. 459), short, with oblique margins. The length of the basal joint is 0.30 mm. The promargin is smooth, with a scanty scopula composed of a few hairs. The retromargin has four stout teeth. Sternum longer than wide in ratio 30:25. First pair of coxae wide apart.

Leg formula	4	1	3	2
	1.8	1.7	1.5	1.5

	Femur	Pat. + Tib.	Metat.	Tarsus	Total
I	1.16	1.16	0.64	0.40	3.36
II	0.85	1.10	0.60	0.40	2.95
III	1.00	1.05	0.50	0.40	2.95
IV	1.10	1.30	0.80	0.44	3.64

Width of first patella 0.240 mm. First tibial index 21.

Width of fourth patella 0.216 mm. Fourth tibial index 17.

*Spines.* First leg. Femur dorsal 1-1-1, prolateral 0-0-1, elsewhere 0. Patella 0. Tibia ventral 2-2-2, the first pair near base, elsewhere 0. Metatarsus ventral 2-2, elsewhere 0.

Second leg same as first except femur retrolateral 0-0-1. Metatarsus prolateral 0-1, retrolateral 0-1.

Third leg. Femur dorsal 1-1-1, prolateral 0-0-1, elsewhere 0. Patella prolateral 1, elsewhere 0. Tibia dorsal 1 bristle near base, prolateral 0-0-1, retrolateral 1-1-1, ventral 2-2-2. Metatarsus dorsal 0, prolateral 1-1, retrolateral 1-1, ventral 2-2.

Fourth leg same as third, except patella retrolateral 1, tibia ventral 1p-1p-2.

The legs are clothed with fine, simple hair. Claw-tufts well developed, composed of true tenent hairs. Two claws (Fig. 458), dissimilar. Proclaw with a row of 13 or 14 teeth. Retroclaw with four small teeth.

The abdomen is 2.3 mm. long, 1.4 mm. wide, clothed with simple light-colored hair. Six spinnerets, cylindrical. First pair stouter and a little longer than posterior pair. The palpi are plainly visible. The tibia has two apophyses (Fig. 457). The one is dorsoretrolateral, is longer and stouter than the other which is ventroretrolateral. Both are curved, pointed and directed forward. The embolus (Fig. 457-EM) is long, needle-like and arises from the anterior prolateral end of the bulb. A sclerite of claw-like appearance arises from the ventroretrolateral end of the bulb.

3. *Immature male in penultimate instar.* Specimen presented by Th. S. Painter and donated by me to the Peabody Museum. Plate LVII, Fig. 528. Plate VI, Fig. 51. A well preserved specimen in amber which is darker near the spider. Ventral surface and mouthparts coated with white emulsion. The color of the chitin is dark brown above, brown below, abdomen lighter.

Total length 4.48 mm. Carapace 1.88 mm. long, 1.32 mm. wide, high, with steep posterior declivity. The head is flat and slightly depressed in the middle. The width of the head is greater than the width of the third row of eyes (Fig. 51). The eyegroup is wider than long in ratio 33:25. The eyes of the first row are contiguous. The eyes of the second row are slightly nearer to the ALE than to the PLE. The carapace is very sparsely clothed with simple hair. A few long bristles are present on the clypeus and on the sides of the head. Chelicerae and mouthparts not visible. The sternum is truncated in front, bluntly pointed behind, longer than wide. The first coxae are wide apart. The fourth coxae are separated by their width.

Leg formula	$\frac{4}{2.1}$	$\frac{1}{1.6}$	$\frac{3}{1.6}$	$\frac{2}{1.5}$
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	Femur	Pat. + Tib.	Metap.	Tarsus	Total
I	0.92	1.20	0.60	0.32	3.04
II	0.92	1.04	0.52	0.32	2.80
III	0.96	1.00	0.60	0.40	2.96
IV	1.20	1.40	0.88	0.40	3.88

Width of first patella 0.216 mm. First tibial index 18.

Width of fourth patella 0.216 mm. Fourth tibial index 15.

*Spines.* First leg. Femur dorsal 1-1-1, elsewhere 0. Patella dorsal 1 apical slender spine, elsewhere 0. Tibia ventral 2-2-2 (the first pair near base), elsewhere 0. Metatarsus ventral 2-2, elsewhere 0.

Second leg same as first, except femur retrolateral 0-0-1.

Third leg femur dorsal 1-1-1, elsewhere 0. Patella dorsal 1-1 bristles, prolateral 1 very small spine, retrolateral 1, ventral 0. Tibia dorsal 1-1, prolateral 0-0-1, retrolateral 0-1-1, ventral 1p-1p-2. Metatarsus dorsal 0, prolateral 1-1, retrolateral 1-1, ventral 2-2.

Fourth leg same as third, except femur retrolateral 0-0-1. Tibia dorsal 0, prolateral 0-1-0, retrolateral 1-1-0.

Trichobothria in two rows on tibiae and metatarsi, in one row on tarsi. Claw-tufts well developed. Two slightly dissimilar claws with a row of 7 or 8 teeth.

The abdomen is ovoid, with an almost pointed posterior end, 2.6 mm. long, 1.6 mm. wide, clothed with recumbent, simple hair and fine bristles. Six spinnerets, cylindrical. Posterior pair separated by the anal tubercle. On the rounded terminal joint three large spigots are visible. The palpi are with a swollen terminal joint.

Genus *Paralinus*, nov.

Carapace fairly high, with steep posterior declivity and longitudinal thoracic groove. Width of third row of eyes smaller than width of head. Eyes of second row as large as eyes of third row and situated about half way between the ALE and the PLE. Chelicerae weak, the pair of them considerably narrower than the face. Sternum convex, wide in front, pointed behind, longer than wide. First coxae wide apart. Order of legs 4312. First and second tibia with a row of three dorsal spines. None of the legs modified. Six cylindrical spinnerets. Claw-tufts well developed. Two slightly dissimilar claws. Tibia of male palp with a mid-dorsal spinelike apophysis closely applied to the dorsal surface of and almost as long as the cymbium. Type *P. crosbyi*.

*Paralinus crosbyi*, n. sp. Plate LXIX, Fig. 616. Plate XLVIII, Figs. 447 to 455.

*Type.* Mature male, No. 1 in the Crosby collection of Cornell University. A very well preserved specimen in clear amber. There is a big bubble of air in the cephalothorax and some white emulsion around the mouth. The spider lies close to the surface which has a peculiar shape and cannot be cut or polished, but that interferes little with vision. The color of the chitin is dark rufous, the palpi almost black.

Total length measured as sum of carapace and abdomen because of peculiar position of the latter 4.2 mm. Carapace 2.0 mm. long, 1.9 mm. wide between second and third coxae where it is widest, 1.2 mm. wide in the region of the third row of eyes (Fig. 447). Width of first row of eyes 1.40 mm., of second row 1.00 mm., of third row 1.25 mm. The third row of eyes is narrower than the head. The eyegroup is wider than long in ratio 35:30. Ratio of eyes AME:ALE:PME:PLE = 17:10:9:9. The eyes of the second row are situated to the inside of and somewhat behind the ALE, about half way between the ALE and the PLE. The carapace is high, with a very steep posterior declivity and a long, line-like thoracic groove. The clypeus is concave, equal to the radius of the AME. The eyes of the first row are contiguous. The carapace is clothed with simple hair. Some of this hair, especially on the right side, has the appearance almost of scales. This is however, only an illusion due to coating with emulsion as can be easily ascertained by examination under high power in strong light.

There are no scales on any part of the body or legs. Long brown bristles are present on the head and on the clypeus.

The chelicerae are slender, their combined width being much less than the width of the head (Fig. 449). The margins are oblique. The armature cannot be seen. The fangs are short and quite slender. The lip (Fig. 455) is wider than long, with procurved suture. The sternum is convex, wide in front, pointed behind, longer than wide. Anteriorly it has a procurved excavation for the reception of the lip. The first coxae are wide apart.

Leg formula	4 2.9	3 2.7	1 2.4	2 2.4		
	Femur	Pat. + Tib.	Metat.	Tarsus	Total	
I	1.40	1.68	1.20	0.60	4.88	
II	1.40	1.68	1.20	0.56	4.88	
III	1.60	1.60	1.60	0.60	5.40	
IV	1.60	1.90	1.68	0.60	5.78	

Width of first patella 0.264 mm. First tibial index 16.

Width of fourth patella 0.288 mm. Fourth tibial index 15.

The legs are distinctly spinose, the spines stout and long.

First leg. Femur dorsal 1-1-1, prolateral 0-1-1, retrolateral 0-1-1, ventral 0. Patella dorsal 1-1 bristles, prolateral 1, retrolateral 1, ventral 0. Tibia dorsal 1-1-1 (the distal one a bristle situated close to the second spine), prolateral 1-1, retrolateral 1-1, ventral 2-2-2 (the first pair close to base). Metatarsus dorsal 1-1, prolateral 0, retrolateral 0, ventral 2-2.

Second leg same as first.

Third leg. Femur dorsal 1-1-1, prolateral 1-1-1, retrolateral 0-1-1, ventral 0. Patella dorsal 1-1 bristles, prolateral 1, retrolateral 1, ventral 0. Tibia dorsal 1-1, prolateral 1-1, retrolateral 1-1, ventral 0-0-2. Metatarsus dorsal 1-0-1, prolateral 1-1-1, retrolateral 0-1-1, ventral 2-0-2.

Fourth leg same as third except femur prolateral 0-0-1, retrolateral 0-0-1. Metatarsus dorsal 0, prolateral 1-1-1, retrolateral 1-1-1, ventral 1r-0-2.

The legs are clothed with fine, simple hair. Trichobothria are numerous, in two rows on tibiae, metatarsi and tarsi.

The claw-tufts are well developed, composed of true tenent hairs (Fig. 453). Two claws, slightly dissimilar, powerful, curved, with

long and stout teeth. The proclaw has 5 or 6 teeth, the retroclaw only 4 teeth.

The abdomen (Fig. 450) is elongated, distinctly narrower than the carapace, transversely truncated in front, more or less pointed behind. It is 2.10 mm. long, 1.15 mm. wide. On the dorsal surface in the posterior third one can see five transverse white lines representing the remnant of segmentation. The abdomen is clothed with two kinds of simple hair. The one is more numerous, fine, recumbent, the other more or less erect, bristle-like. Six cylindrical spinnerets (Fig. 454). The anterior pair are contiguous and somewhat stouter than the posterior pair which are separated by the anal tubercle. The median spinnerets are only imperfectly visible. The palpi are well preserved and characteristic. The cymbium is longer than the femur and unusually large (Fig. 451). The tibia has a dorsal median crest from the end of which a long spine-like apophysis arises. This is so curved that it is closely applied to the back of the cymbium and so long that it reaches almost to the end of the latter. The bulb (Fig. 452) has at its end a fine and slightly curved, needle-like embolus accompanied by a conductor which arises close to the base of the bulb and is therefore much longer than the embolus. In a certain position of the palp one can see the embolus, the conductor and the tibial apophysis at the same time.

#### Genus *Cenattus*, nov.

Carapace almost rectangular, narrower than the third row of eyes, high, with steep posterior declivity. All eyes on high pedestals. Eyes of second row two-thirds as large as the ALE and situated immediately behind them. Eyegroup wider than long. Sternum convex, as wide as long. First coxae wide apart. Fourth coxae contiguous. Order of legs 4312. None of the legs modified. First tibia with only ventral spines, three pairs the first of which is near base. Claw-tufts well developed. Two claws, similar, slender, with a long row of small teeth. Abdomen ovoid. Integument with simple hair only. Type *C. exophthalmicus*.

*Cenattus exophthalmicus*, n. sp. Plate LVI, Fig. 523, Plate IV, Figs. 33 to 36.

1. Type. Mature female. British Museum, In. 17617.  
Seeböhm's Bequest.



2. Immature male. British Museum, In. 18130. Collection from Samland.

*Description of Type.* An almost complete, but rather poorly preserved specimen in amber full of air pockets and reflections. The fourth left leg was autotomized in life and is missing. The color of the chitin is dark brown.

Total length 3.03 mm. Carapace (Fig. 33) high, somewhat narrower than the third row of eyes which protrude beyond its sides. The carapace is 1.22 mm. long, 1.07 mm. wide between the eyes of the second and third row. Width of first row of eyes 1.32 mm., second row 1.17 mm., third row 1.32 mm. All eyes are elevated on high pedestals which give them a peculiar appearance. Ratio of eyes AME:ALE:PME:PLE = 16:9:6:9. AME contiguous, but distinctly separated by a deep cleft from the ALE. The axis of the latter is directed somewhat upward and outward at an angle of about 45°. The PME have almost a similar position, but are looking a little more upward. The eyes of the third row are directed somewhat forward, outward and upward. The eye-group is wider than long and the head is flat between the eyes. There is no hair on the carapace except on the sides and on the clypeus. The posterior declivity is steep. It is covered by the abdomen and can be seen only in sideview.

The view of the chelicerae and mouthparts is obstructed by white emulsion. The sternum is convex, shield-shaped, as wide as long, sparsely clothed with hair. The first coxae are wide apart. The fourth coxae are contiguous.

Leg formula	4	3	1	2
	6.6	5.2	5.1	4.6

	Femur	Pat. + Tib.	Metat.	Tarsus	Total
I	0.87	1.10	0.52	0.30	2.79
II	0.75	1.04	0.46	0.30	2.55
III	0.99	0.92	0.63	0.30	2.84
IV	1.16	1.21	0.87	0.40	3.64

*Spines.* First leg. Femur dorsal 1-1-3, elsewhere 0. Patella prolateral 1, retrolateral 1, elsewhere 0. Tibia ventral 2-2-2 (the first pair near base), elsewhere 0. Metatarsus ventral 2-2, elsewhere 0.

Second leg same as first.

Third leg. Femur dorsal 1-1-3, elsewhere 0. Patella dorsal 0-1, prolateral 1, retrolateral 1, ventral 0. Tibia dorsal 1-1, prolateral 1-1, retrolateral 1-1, ventral 2-2-2. Metatarsus dorsal 0, prolateral 0-1-2, retrolateral 0-1-2, ventral 1-0-1.

Fourth leg same as third.

The first and second legs are somewhat stouter than the posterior four legs and their spines are also stouter.

The claw-tufts are well developed, but not dense. Two claws (Fig. 36), similar, slender and long, with a long row of small teeth, visible only under high power and then in transmitted light only. The legs are clothed with simple hair. The palpi are large and their terminal joint is as long as the patella and tibia together. A palpal claw is wanting.

The abdomen is ovoid, 2.05 mm. long, 1.70 mm. wide, sparsely clothed with fine hair. The epigynum is very prominent, dark brown, wider than long, surrounded by curved hair. Under high power one can see the two receptacles with their ducts to the end portion of the uterus and the two fertilization ducts (Fig. 34).

Six spinnerets, cylindrical. The anterior spinnerets are contiguous and as long as the posterior spinnerets which are separated by the width of the anal tubercle. The median spinnerets are shorter, more slender and contiguous.

#### Branch *Quadrostriatae*

The position of the *Quadrostriatae* is still greatly misunderstood by arachnologists. The Branch was established by me for the reception of dipneumone spiders with quadrostriate heart. The "primitive" appearance of these spiders and of their external copulatory apparatus led the majority of specialists into the unfortunate error of confusing the idea of simplicity of structure with primitiveness of origin. In Koch's time the anatomy of these spiders was quite unknown. Simon was in a better position to form a judgment concerning them, because he was familiar with the anatomical investigations of Causard and of Lamy. Nevertheless Simon did not grasp their meaning, partly because knowledge was still insufficient, partly because he could not get away from the idea that simplicity of structure bespeaks primitiveness of origin. Consequently he paid no attention whatsoever to the circulatory and respiratory systems of spiders in erecting his classification and divided them instead into *Haplogynae* and *Entelogyinae*

in accordance with the state of their external genital apparatus. That was a great mistake. The difference in the structure involves only external characters in the female and only accessory characters in the male. The internal copulatory apparatus of the female and the receptacle of the male palp present similar, almost identical features in both Haplogyne and Entelogyne spiders. Simon was aware of course of the case of those Entelogyne Argiopid spiders which he separated in his Subfamily *Tetragnathinae*. To explain the simplicity of their genital organs he regarded them as representatives of a very ancient type. "Sous ce rapport, les *Tetragnathinae* sont très intéressants, car ils semblent représenter, dans la nature actuelle, un type fort ancien dont seraient issus les *Linyphia* et les *Argiope*." Now there is no doubt that the evolution of the heart in spiders followed a reduction in the number of ostia and not an increase in their number. There is also no doubt that the book-lungs are older characters than tracheal tubes and that the entrance of the latter into the cephalothorax must have taken place *subsequent* to their replacement of the second book-lungs in the abdomen. Since we find spiders with simplified genital organs both among quadrostiate and sexostiate spiders, this can mean only one thing, namely that the evolutionary changes of the genital system are independent of those of the respiratory and circulatory systems. The system proposed by me in my Inquiry and explained in the General Part of the present monograph avoids these difficulties. The quadrostiate spiders represent the end of the evolutionary trend and in this regard are later products of evolution than sexostiate spiders even though they may be their contemporaries. It is interesting to emphasize here the fact that this phase of their evolution was completed already in the Oligocene if we are right in assuming that identity in other characters makes identity in the structure of the heart and tracheal system certain.

In my System the Branch *Quadrostiatae* contains ten families. Three of these are represented in the Baltic amber, *Segestriidae*, *Dysderidae* and *Oonopidae*. Koch, as the majority of present day arachnologists, did not separate the *Segestriidae* from the *Dysderidae*. He described three genera, *Segestria*, *Dysdera* and *Therea*. Of these *Therea* alone is extinct. Koch described also a species of *Anyphaena* (*A. fuscata*) from the Baltic amber, which would belong in my system in the Branch *Quadrostiatae* if the genus is correctly identified.

Family *Segestriidae*Genus *Segestria* Latreille, 1804Type *S. florentina* (Rossi)

The Genus *Segestria* is represented by several species in the recent fauna of the Old and New World. Koch described four species from the Baltic amber, *S. tomentosa*, *S. elongata*, *S. cylindrica*, and *S. nana*. Menge listed on p. 74 four additional species, *S. cristata*, *S. pusilla*, *S. exarata* and *S. undulata*. Menge's diagnoses of these species are each less than a line long and quite inadequate for identification. His four species must be therefore regarded as *nomina nuda*.

*Segestria elongata* Koch and Berendt, 1854, p. 72, Tab. VII, Fig. 65.

1. Female. Hypotype. British Museum, In. 18736, coll. Klebs 493, No. 13415. Plate LXII, Fig. 568. Plate XIII, Figs. 124 to 128.
2. Female. British Museum, In. 18717, coll. Klebs 475, No. 13445. Plate LXI, Fig. 562.

1. *Description of Hypotype.* British Museum, In. 18736.

A well preserved specimen in clear amber. The left first leg was autotomized in life and is missing, otherwise the specimen is complete. There is some white emulsion present between the chelicerae and on the sides of the abdomen. There is also a dark, reddish brown mass present on the sternum. The color of the chitin is a deep reddish brown on the carapace, legs somewhat lighter, abdomen considerably lighter, venter yellowish with sternum darker than coxae.

Total length including chelicerae 6.5 mm. Carapace (Fig. 125) 2.4 mm. long, 1.9 mm. wide between second and third coxae where it is widest, 1.2 mm. wide in the region of the eyes. The front margin is transversely straight. The head is clearly outlined by the cephalothoracic sulci. A thoracic groove is wanting. The carapace is clothed with fine hair directed forward and a few fine bristles on the head in front of the eyegroup. Six eyes, all of the same size. First row slightly procurved, composed of four eyes. AME contiguous and slightly, but distinctly separated from the ALE. The lateral eyes are contiguous and the second row which

is formed by only two eyes, is slightly wider than the first row. The eyegroup is not as wide as the head, but narrower by at least two diameters of the eyes. Viewed from in front (Fig. 124) the first row of eyes is slightly down-curved. The clypeus is equal to the diameter of the AME.

The chelicerae are rather long and stout, with almost parallel outer edges, without boss. The margins cannot be seen, but a well developed promarginal scopula is visible when the specimen is viewed from below. The fangs are short. Anteriorly the chelicerae are clothed with brown bristles. The maxillae are with a very convex outer edge and a well developed scopula. The lip cannot be seen well, but its tip with hair is visible reaching about the middle of the maxillae. The sternum is fairly flat, longer than wide, clothed with bristles. The first pair of coxae is wide apart. Fourth coxae separated by not quite the half of their width. All legs seem to be directed forward, but the fourth femora are directed backward. Consequently it is safe to assume that the position of the rest of the fourth legs is the result of struggle to free itself from the gum and that *S. elongata* had only three pairs of legs directed forward as is the case in all recent representatives of the genus.

Leg formula	1	2	4	3
	3.1	3.0	2.9	2.4

	Femur	Pat. + Tib.	Metat.	Tarsus	Total
I	2.28	2.80	1.60	0.80	7.48
II	2.08	2.80	1.48	0.72	7.08
III	1.72	2.12	1.20	0.68	5.72
IV	2.08	2.60	1.36	0.80	6.84

Width of first patella 0.336 mm. First tibial index 12.

Three claws. Upper claws slightly dissimilar. Proclaw (Fig. 127) with eight teeth which are somewhat stouter and less inclined forward than the ten teeth of the retroclaw (Fig. 128). The third claw is bent at right angles and has a long, curved, fine tooth. Serrated bristles and claw-tufts wanting. Scopulae are also wanting. Trichobothria are difficult to see. Spines are present, but rather short.

*Spines.* First leg. Femur dorsal 1-1-1, prolateral 0-1-1, elsewhere 0. Patella 0. Tibia retrolateral 1-1-1, ventral 2-2-2-2, elsewhere 0. Metatarsus prolateral 1-0, ventral 2-2, elsewhere 0.

Second leg same as first.

Third leg. Femur dorsal 1-1-1, prolateral 0-0-1, elsewhere 0. Patella 0. Tibia ventral 2-2-2, elsewhere 0. Metatarsus ventral 2-2, elsewhere 0.

Fourth leg same as third.

The legs are clothed with two kinds of hair, one is woolly and short, the other much longer, curved and directed forward. On the dorsal surface of the metatarsi, but not of other segments, there are short, stout, erect bristles.

The palpi are of the female type. The palpal claw (Fig. 126) is gently curved and smooth.

The abdomen has the shape of an ellipsoid, 3.5 mm. long, 2.4 mm. wide. It is clothed with bristles both above and below. The spinneret group has the shape of an elongated oval whose long axis coincides with the axis of the body. The anterior spinnerets are contiguous and as long as the posterior ones. The median pair cannot be seen. The anal tubercle is almost as long as the spinnerets.

2. Specimen in the collection of the British Museum, In. 18717. Plate LXI, Fig. 562.

This specimen is not as well preserved as the Hypotype. As it belongs to the same species, a detailed description is not necessary. Suffice it to mention that the promargin of the chelicerae is smooth, with a scopula and that the sternum is oval, longer than wide, bluntly pointed behind. Carapace 2.22 mm. long, 1.74 mm. wide between second and third coxae, 1.08 mm. wide in the region of the eyes. The first leg is 6.1 mm. long.

### Family Dysderidae

Koch described one species of *Dysdera* (*D. tersa*) and two species of *Therea* (*Th. petiolata* and *Th. hispida*). According to Menge the last species, *Therea hispida*, is identical with *Melanophora mundula* and belongs therefore into the family *Drassodidae*. In a footnote on page 74 Menge mentions three other species of *Dysdera*, *D. hippopodium*, *D. scobiculata* and *D. glabrata*. Although Menge's descriptions of these species are quite inadequate I believe that *D. scobiculata* can be recognized. According to Menge its carapace is "feinnarbig" and the abdomen "leicht gefurcht".

Genus *Dysdera* Latreille, 1804Type *D. erythrina* Latreille*Dysdera scobiculata* Menge, 1854, p. 74.

Hypotype. Female. British Museum, In. 18769, coll. Klebs 527, No. 13431. Plate LVII, Fig. 529, Plate VII, Figs. 59 and 60. A complete, but poorly preserved specimen. The amber is full of air bubbles and the spider is heavily coated with white emulsion. The color of the chitin of the carapace and legs is dark brown.

Total length 5.03 mm. Carapace 2.16 mm. long, between 1.60 and 1.75 mm. wide. It cannot be measured exactly because of the position of the spider in the amber. Posteriorly the carapace is gradually narrowed and truncated. Anteriorly it is very little narrowed so that the compact eyegroup (Fig. 60) is at least three times narrower than the head. No thoracic groove is visible. The surface of the carapace is finely granular and free from pubescence except for a few hairs on the head. Six eyes in a compact group forming a transverse ellipse. The four median eyes are equal, the two lateral ones slightly, but distinctly larger. All eyes are contiguous, but the central quadrangle has a free space separating the anterior from the posterior pair. The clypeus is high, but cannot be measured.

The chelicerae are stout and long, distinctly geniculated, sparsely clothed with bristles. A boss is wanting. Maxillae, lip, sternum and coxae completely hidden from view by a thick layer of white emulsion.

Leg formula	4	1	2	3		
	2.9	2.7	2.5	2.2		
	Femur	Pat. + Tib.	Metat.	Tarsus	Total	
I	1.72	2.36	1.20	0.48	5.76	
II	1.60	2.28	1.24	0.44	5.56	
III	1.40	1.60	1.24	0.44	4.68	
IV	2.00	2.28	1.60	0.48	6.36	

An unusual feature of the legs is the extraordinary length of the patellae, especially of the first pair. They are fully 1.10 mm. long, while the tibia is 1.26 mm. long. The fourth patella is 0.88 mm. long and the fourth tibia 1.48 mm. These measurements were made in the mid-dorsal line. The first and second legs seem to be quite free of spines, the third and fourth legs are, on the contrary,

quite spinose, but the distribution of the spines cannot be fully ascertained. On the right femur of the third leg a dorsal spine is visible near base and a prolateral spine near distal end. On the fourth leg a corresponding dorsal spine is visible on the femur. On the fourth tibia the spination seems to be: dorsal 0, prolateral 1-1-1, retrolateral 1-1-1, ventral 2-2-2. On the fourth metatarsus several stout spines are visible, including an apical verticellum.

The size of the coxae is also unusual. The first coxa is not visible. The second coxa is 0.70 mm. long, not including the basal condyle, and 0.34 mm. wide in middle. The third and fourth coxae are short and wide, almost globular in appearance. All trochanters are small. Two claws (Fig. 59). They are more or less concealed by hair, similar, curved, with a row of four teeth. Claw-tufts seem to be wanting, but at the end of one tarsus two especially stout hairs can be seen under the claws. The palpal claw is small, curved, smooth.

The abdomen is ellipsoidal, 3.0 mm. long, 1.8 mm. wide. It is thickly coated with white emulsion above and below. One can see the spinnerets and the genital fold, but no detail can be made out. Through the emulsion the short hair with which the abdomen is clothed is visible.

### Family *Oonopidae*

Although one species described below, belonging to this family seems to have been one of the most common ones in the Oligocene and is represented by many specimens in the Baltic amber, it escaped observation so far. There is nothing extraordinary in this. All *Oonopidae* are very small and *Orchestina baltica* is no exception in this respect. The adult measures less than 1.5 mm. In Koch's time it must have been confused with young spiderlings from which it can be distinguished only under fairly high power. Its frequency in amber is also easily understood. *Oonopidae* make no webs and being equipped with greatly thickened posterior femora are adapted for leaping. Roaming in quest of prey thousands of them must have been caught in the sticky gum. Being of small size their body fluid did not emulsify the gum. As a consequence the preservation is exceptionally good and the creatures, notwithstanding their small size, may be easily studied in great detail.

While not a large family, the recent *Oonopidae* count some thirty genera distributed over two subfamilies. The family has



representatives all over the World and the Genus *Orchestina* to which the Baltic amber species also belongs is known from Europe, Asia, Africa, America and Australia. The fossil species cannot be referred to any of the recent ones. Like other amber species it seems to be totally extinct.

Subfamily *Oonopinae*

Genus *Orchestina* Simon, 1892

Type *O. pavesii* Simon

*Orchestina baltica*, n. sp.

1. Type. Mature male. British Museum, collection from Samland, In. 18138. Plate LIX, Fig. 548. Plate VII, Figs. 55 and 56. Plate XXV, Fig. 234.
2. Mature male. British Museum, In. 18714, coll. Klebs 472. No. 13414. In the same piece of amber with *Collacteus captivus*.
3. Mature male. British Museum, In. 29124—A, coll. A. Théry. Plate XXV, Figs. 235 to 237. (In the same piece of amber with the immature specimen, In. 29124—C.)
4. Mature male. British Museum, In. 29124—B, coll. A. Théry. Plate VI, Fig. 54, Plate XXV, Fig. 233.
5. Gynetype. Mature female. British Museum, collection from Samland, In. 18137. Plate LIX, Fig. 549, Plate VI, Fig. 52.
6. Mature female. British Museum, collection from Samland, In. 18947. Plate LIX, Fig. 550.
7. Mature female. Cornell University, Crosby collection No. 4. Plate LXIX, Fig. 626.
8. Immature. Sex? British Museum, collection A. Théry, In. 29132—A. Plate LIX, Fig. 547. Plate VI, Fig. 53.
9. Pullus. British Museum, collection A. Théry, In. 29124—C. (In the same piece of amber with No. 3 mature male In. 29124—A.)

(In addition, 8 mature males and 5 mature females in the collection of the Harvard University Museum of Comparative Zoology, on which a report will be made in a separate paper.)

Description of male *Orchestina baltica*.

1. *Type*. British Museum, In. 18138, Plate LIX, Fig. 548. Plate VII, Figs. 55 and 56.

Total length 1.03 mm. Carapace 0.55 mm. long, 0.43 mm. wide (Fig. 56), gradually narrowed anteriorly, truncated posteriorly. The carapace is high and the posterior declivity is steep. At the highest point the carapace is 0.19 mm. high and slopes forward from here on almost in a straight line. A median crest of four bristles extends from the highest point to the eyegroup. Six eyes, all of the same size. Anterior four eyes and the lateral eyes contiguous. Viewed from above the first row of eyes is straight and shorter than the width of the head. The clypeus is as high as three diameters of the eyes. Several bristles are visible on its edge (Fig. 234).

The chelicerae are parallel, with oblique margins. The basal joint is 0.13 mm. long. The view of the mouthparts and of the sternum is obstructed by an air bubble. The legs are very unequal in length. The fourth femur is longer and stouter than the others and considerably distended in middle (Fig. 55), being adapted for jumping as in recent species. Its greatest dorso-ventral axis is 0.08 mm. long.

Leg formula	4	1	2	3
	1.5	1.4	1.3	1.2

	Femur	Pat. + Tib.	Metat.	Tarsus	Total
I	0.22	0.27	0.16	0.11	0.76
II	0.23	0.27	0.13	0.11	0.74
III	0.18	0.21	0.15	0.11	0.65
IV	0.26	0.25	0.20	0.11	0.82

The legs are smooth. A median row of bristles is visible on the back of the first right femur and a single dorsal bristle near the base on the tibia. The claws cannot be seen.

The abdomen is almost globular, clothed with long bristles. Its anterior end considerably overlaps the carapace. Only one pair of the spinnerets can be seen. They are cylindrical and fairly long. The other spinnerets are hidden from view.

The palpi are large when compared with the size of the spider. They are typical of the genus, with a long and pointed embolus, but so flexed that a figure cannot be given. However, its appearance is identical with that of specimen 29124—B.

2. *Specimen In. 18714.* This specimen lies so close to the surface of the piece of amber that it was partly polished off by the previous owner. The result is that the inside of the spider is exposed to view. Only the right third and fourth legs are complete. Total length 1.13 mm. Carapace 0.55 mm. long. Abdomen 0.65 mm. long, 0.53 mm. high. Fourth femur dorso-ventrally distended. Palp with greatly swollen tibia which by comparison with the slender femur looks very large. Cymbium as large as tibia, more or less heart-shaped, with a long, pointed embolus.

3. *Specimen In. 29124—A.* Plate XXV, Figs. 235 to 237. Total length 1.08 mm. Carapace 0.58 mm. long, 0.41 mm. wide in middle where it is widest. The specimen shows clearly the sternum, coxae and both palpi. The lip is free, about as wide as long, with convex anterior edge and procurved suture. The sternum (Fig. 237) is oval, longer than wide, rounded between the hind coxae which are separated by somewhat more than their width. The first coxae very far apart. All coxae of the same side separated from each other by the lateral lobes of the sternum, which extend to the edge of the carapace and form part of the coxal sockets. The legs show the same disproportion as in the type. The femur of the first leg (Fig. 235) is slender, that of the fourth leg (Fig. 236) is much stouter, longer and dorso-ventrally distended. The palp closely resembles that of the type.

4. *Specimen In. 29124—B.* Plate VI, Fig. 54, Plate XXV, Fig. 233. Total length 1.08 mm. Carapace 0.57 mm. long, 0.48 mm. wide, head 0.216 mm. wide. Chelicerae converging, slender, with concave anterior surface. Maxillae almost as long as chelicerae. Fourth femur greatly distended dorso-ventrally. Abdomen high, 0.55 mm. long, overlapping the carapace. Spinnerets long, cylindrical. Palpi bent against the sternum, well visible. The femur slender. Tibia (Fig. 54) much stouter and somewhat longer than the femur. Cymbium shorter than the tibia, but the bulb enormous and the embolus long and slender.

5. *Gymetypa.* British Museum, In. 18137. Plate LIX, Fig. 549. Plate VI, Fig. 52.

Total length 1.44 mm. Carapace 0.68 mm. long, 0.52 mm. wide, gradually narrowed anteriorly, 0.48 mm. high at the highest point.

Posterior declivity steep. Anteriorly the carapace slopes down in an almost straight line. A few bristles form a mid-dorsal line. Six eyes, all of the same size. Eyes of first row contiguous, lateral eyes also contiguous. Clypeus quite prominent, bulging, 0.1 mm. high, *i. e.* twice as high as the diameter of the eyes.

The chelicerae are parallel and fairly long. Their margins are not visible. The maxillae are inclined over the lip. The lip is almost triangular, about as long as wide at base. The sternum is quite convex, very wide in front, bluntly pointed between the hind coxae which are separated by their width. First coxae wide apart. First and second pair of legs were autotomized in life and are missing. Femur of fourth leg longer and stouter than that of the third leg and distended dorso-ventrally. The legs are smooth. A bristle is present on the tibia before middle and on the metatarsus toward the end. There is very little hair on the legs. Claw-tufts are wanting. Two claws, similar, curved, on an onychium. Trichobothria few, one on the metatarsus beyond middle, possibly one on the tibia in the middle, but its nature is not certain. Some of the hair on the fourth metatarsus is so stout that it looks almost like bristles.

	Femur	Pat. + Tib.	Metat.	Tarsus	Total
III	0.36	0.50	0.45	0.19	1.50
IV	0.65	0.67	0.57	0.24	2.13

The abdomen is ovoid, its dorsal surface longer than the ventral one. It is 0.80 mm. long without spinnerets, 0.40 mm. high, clothed with long, curved bristles. The spinnerets (Fig. 52) are equal in length, cylindrical, the two anterior and the two posterior ones contiguous, forming a square with the two median ones between them. The anal tubercle is visible only in side-view. The bristles on the sides of the abdomen have a stouter base than those on the back, while those on the ventral surface are much shorter. The genital region is distinctly swollen, but shows no detail.

6. *Specimen, In. 18947, British Museum.* Plate LIX, Fig. 550. This specimen is in a piece of very dark amber. First right, second and fourth left legs are missing.

Total length 1.48 mm. Carapace 0.65 mm. long, 0.53 mm. wide between second coxae, 0.22 mm. wide in the region of the eyegroup. Shape same as in gynetype. Six eyes.

Leg formula	$\frac{4}{3.0}$	$\frac{1}{2.8}$	$\frac{2}{2.1}$	$\frac{3}{1.8}$
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	Femur	Pat. + Tib.	Metat.	Tarsus	Total
I	0.48	0.65	0.46	0.24	1.83
II	0.28	0.40	0.30	0.19	1.17
III	0.38	0.41	0.36	0.19	1.34
IV	0.52	0.64	0.52	0.29	1.97

Two claws on an onychium of considerable length. The claws are fine and curved almost in semi-circle. On one of the claws a short series of long teeth can be seen under high power.

7. *Specimen No. 4* of Cornell University. Plate LXIX, Fig. 626.

Total length 1.34 mm. Carapace 0.50 mm. long, 0.46 mm. wide between second and third coxae, 0.144 mm. wide in the region of the eyegroup. Highest point a little behind middle. Posterior declivity steep. Anteriorly the carapace slopes down in an almost straight line. A mid-dorsal crest of bristles is present on the carapace. Six eyes of the same size. Clypeus high. Chelicerae, mouthparts and sternum as in gynetype. First coxae wide apart.

Leg formula	$\frac{4}{2.7}$	$\frac{1}{2.7}$	$\frac{2}{2.6}$	$\frac{3}{2.2}$
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	Femur	Pat. + Tib.	Metat.	Tarsus	Total
I	0.41	0.43	0.29	0.24	1.37
II	0.38	0.41	0.29	0.24	1.32
III	0.31	0.34	0.24	0.19	1.08
IV	0.43	0.43	0.31	0.20	1.37

Fourth femur dorso-ventrally distended. One trichobothrium on the tibia a little before middle, one on the metatarsus a little beyond middle. Two claws on an onychium, curved, slender and long with four teeth.

The abdomen is ovoid, overlapping the carapace, 1.08 mm. long, 0.67 mm. wide, 0.74 mm. high. Six cylindrical, equally long spinnerets. Genital region distinctly swollen.

8. *Specimen In. 29132—A*, British Museum. Plate LIX, Fig. 547, Plate VI, Fig. 53. A rather poorly preserved specimen in otherwise perfectly clear amber.

Total length 0.92 mm. Carapace 0.38 mm. long, with steep posterior declivity. Fourth femur dorso-ventrally distended.

Leg formula	<sup>1</sup> 2.5	<sup>1</sup> 2.4	<sup>2</sup> 2.4	<sup>2</sup> 2.0
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	Femur	Pat. + Tib.	Metat.	Tarsus	Total
I	0.27	0.27	0.30	0.09	0.93
II	0.23	0.30	0.30	0.09	0.92
III	0.22	0.23	0.23	0.09	0.77
IV	0.29	0.30	0.27	0.09	0.95

Two claws (Fig. 53) on a long onychium. The claws of the first and second pair of legs somewhat longer than those of the third and fourth pair, but of the same general appearance. The claws are curved, long and slender, with a row of four teeth.

9. *Specimen In. 29124—C.* The smallest specimen of the lot, undoubtedly quite young. Total length 0.90 mm., carapace 0.40 mm. long. The dorsal portion of the abdomen had been polished off by the previous owner, and with it the spinnerets as well. The fourth femur is slightly dorso-ventrally distended, but not as much as in the mature specimens. The shape of the carapace same as in type.

#### Spiders *Incertae Sedis*

The collection of the Sedgwick Museum, Cambridge, contains two small spiders which are numbered C 6653 and C 6654 respectively and which I am unable to place in their proper family. In view of the possibility of getting some day additional material I thought it desirable to give here as careful an account of the above specimens as possible, to make their eventual identification more certain.

*Specimen C 6653*, very poorly preserved in a dark yellow and imperfect piece of amber. Only the right side of the spider is preserved, so that the view of the interior is unobstructed. The legs can be scarcely recognized, their view being obstructed by white emulsion. The face is visible and shows eight eyes in two rows of four each, a low clypeus and comparatively long and powerful chelicerae. The shape of the carapace cannot be ascertained. The total length is about 2.0 mm. The abdomen is neatly ellipsoidal,

1.28 mm. long, 0.76 mm. wide. Of the legs the first right one and the third and fourth left ones are visible. On one of them two claws can be seen, but it is not possible to determine whether a third claw is present or wanting. The same tarsus shows clearly several long trichobothria curved backward and increasing in length distally. Some spines are also present on the legs.

The disposition of the eyes and the arrangement of the tarsal trichobothria suggest that this may be an Agalenid.

*Specimen C 6654.* A specimen in dark yellow amber, very poorly visible because of imperfections in the immediate vicinity of the spider. The general appearance reminds one of a jumping spider of the Family *Salticidae*, but the presence of a third claw makes this affiliation impossible.

Total length 3.6 mm. Carapace 1.6 mm. long. Its width cannot be measured. It is high and the posterior declivity is steep. The eyes cannot be seen. The chelicerae are stout and strongly convex.

Probable leg formula		4	1	2	3
		?	2.1	1.8	1.7
	Femur	Pat. + Tib.	Metat.	Tarsus	Total
I	1.00	1.16	0.60	0.56	3.32
II	0.72	1.04	0.60	0.52	2.88
III	0.80	0.92	0.60	0.44	2.76
IV	?	1.24	1.80	1.56	?

The legs are sparsely clothed with hair. A few spines are visible. Three claws. Upper claws with a row of eight or nine teeth. Third claw bent at right angles. The palpi are visible, but it is impossible to determine whether a claw is present.

The abdomen is ovoid, 2.2 mm. long including the spinnerets, 1.4 mm. high, sparsely clothed with white hair. The spinnerets are visible only in side view. They are cone-shaped, their terminal joint more slender and longer than the basal joint. The anterior pair is also somewhat longer and stouter than the posterior pair. The median pair is not visible.

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**PLATES I - LXIX**



## PLATE I

FIGURES 1 to 7. *Parevophrys succini* n. g., n. sp. Male. Type. No. C-6656, Sedgwick Museum, University of Cambridge.

FIGURE 1. Carapace viewed from the left side.

FIGURE 2. Ventral view of fangs, lip, sternum, maxillae and coxae.

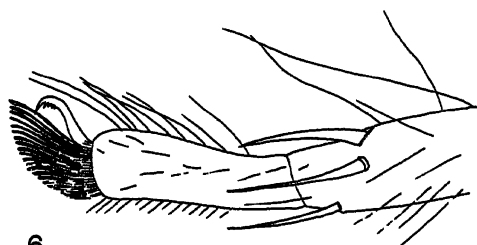
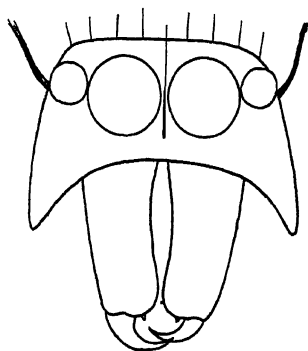
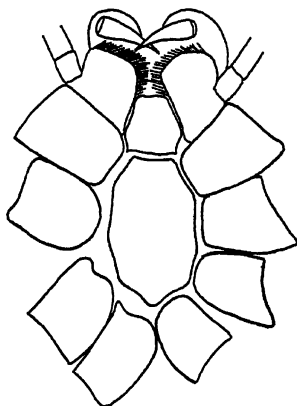
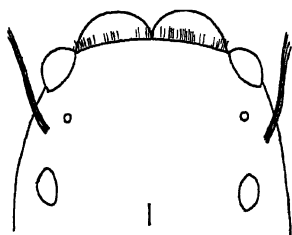
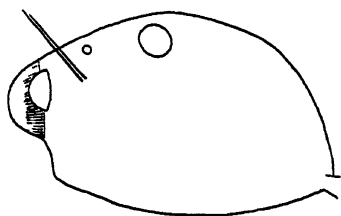
FIGURE 3. Head viewed from above, showing eyegroup and thoracic groove.

FIGURE 4. Front view of face.

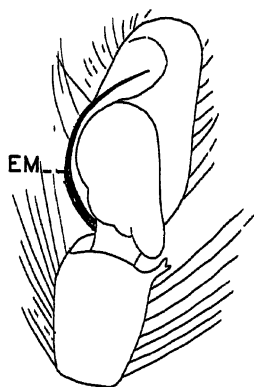
FIGURE 5. Prolateral view of right chelicera showing retromarginal tooth and smooth promargin.

FIGURE 6. Retrolateral view of the end of the third left leg showing retro-claw, claw-tufts and three of the six spines of the metatarsal verticellum.

FIGURE 7. Ventral view of left palp showing tibial apophysis and embolus—EM.



6



7

## PLATE II

FIGURES 8 to 11. *Gorgopis frenata* (Koch and Berendt). Pullus. No. C-6655. Sedgwick Museum, University of Cambridge.

FIGURE 8. Dorsal view of carapace showing eyegroup and the lateral depressions behind the eyes of the second row.

FIGURE 9. Ventral view showing lip, maxillae, sternum and coxae.

FIGURE 10. End of left third tarsus showing claw-tufts and both claws. Notice that the claws are dissimilar.

FIGURE 11. Terminal joint of right posterior spinneret showing the five spigots under high magnification

FIGURES 12 to 15. *Eopopino longipes* n. g., n. sp. Male. Type. No. C-6649. Sedgwick Museum, University of Cambridge.

FIGURE 12. Ventral view showing lip, maxillae, sternum and coxae.

FIGURE 13. End of second left tarsus showing the three claws and two spurious claws. Notice that the upper claws are dissimilar.

FIGURE 14. Right palp viewed from below. Embolus (EM) only partly visible.

FIGURE 15. Portion of left palp viewed from above. Notice short tibia (TI) and screw-shaped paracymbium (PA).

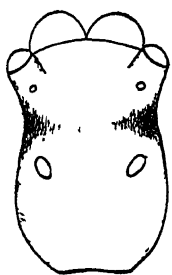
FIGURES 16 to 19. *Eogonatium minutum* n. g., n. sp. Pullus. Type. No. C-6650. Sedgwick Museum, University of Cambridge.

FIGURE 16. Dorsal view of carapace.

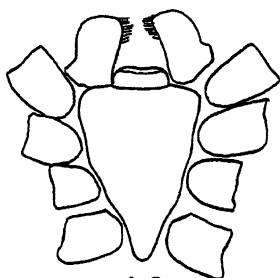
FIGURE 17. End of second left tarsus showing the three claws.

FIGURE 18. Fourth leg showing the single tibial trichobothrium just before middle, and the single metatarsal trichobothrium near distal end of joint.

FIGURE 19. Terminal joint of palp showing the smooth claw.



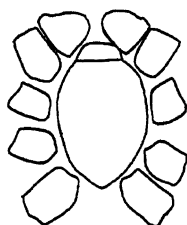
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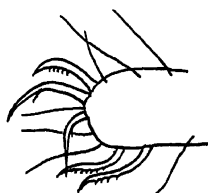
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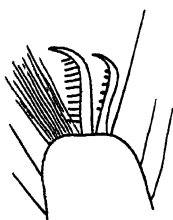
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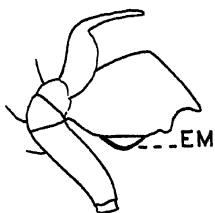
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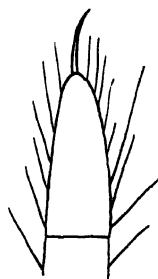
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### PLATE III

FIGURES 20 to 25. *Gorgopis frenata* (Koch and Berendt). Male. Hypotype. Coll. Klebs 496, No. 3773. British Museum In. 18739.

FIGURE 20. Dorsal view of head, showing eyegroup and thoracic groove

FIGURE 21. Front view of face. Notice the maxillae with the serrula.

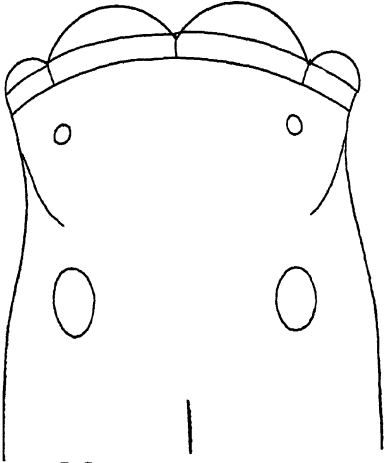
FIGURE 22. Ventral view showing maxillae, lip and sternum.

FIGURE 23. Retrolateral view of the end of the third left tarsus. P—proclaw, R—retroclaw.

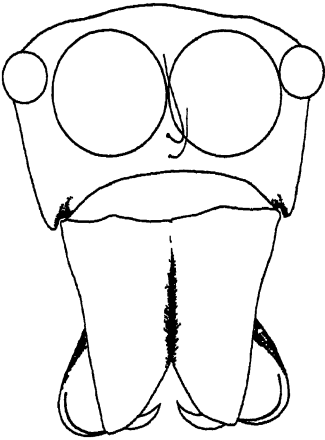
FIGURE 24. Fang of right chelicera and scopula of both margins.

FIGURE 25. Prolateral view of left palp. EM—embolus.

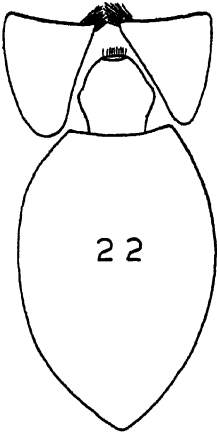
FIGURE 26. *Gorgopis frenata* (Koch and Berendt). Immature male. Coll. Klebs 521, No. 13464. British Museum In. 18763. Anal tubercle and spinnerets viewed from the right side. A—anterior spinneret, M—median spinneret, P—posterior spinneret.



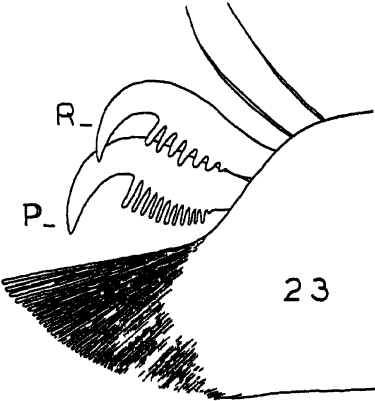
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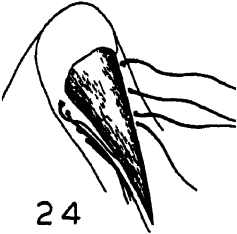
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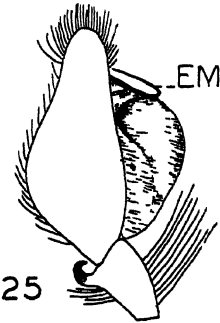
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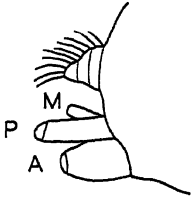
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#### PLATE IV

FIGURES 27 and 28. *Gorgopis frenata* (Koch and Berendt). Male. Parahypotype. Coll. Klebs 511, No. 13432. British Museum In. 18753.

FIGURE 27. Right palp viewed from below. EM—embolus, C—conductor.

FIGURE 28. Right palp viewed from the side.

FIGURES 29 to 32. *Gorgopis frenata* (Koch and Berendt). Immature female. Coll. Klebs 492, No. 13480. British Museum In. 18735.

FIGURE 29. Carapace viewed from above.

FIGURE 30. Spinnerets viewed from below, under high power.

FIGURE 31. Carapace viewed from the left side.

FIGURE 32. Front view of face.

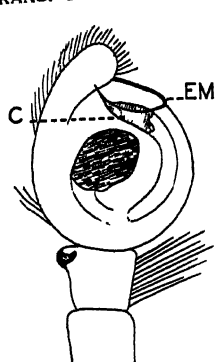
FIGURES 33 to 36. *Cenattus exophthalmicus* n. g., n. sp. Female. Type. Seebohm's Bequest, British Museum In. 17617.

FIGURE 33. Dorsal view of spider. (The legs are omitted.) Notice that all eyes are elevated on tubercles.

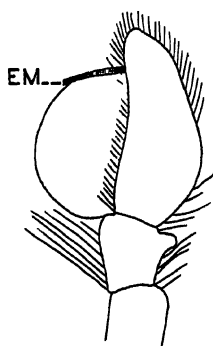
FIGURE 34. Epigynum.

FIGURE 35. Front view of face. In this position the left eye is not visible and is represented by a dotted line.

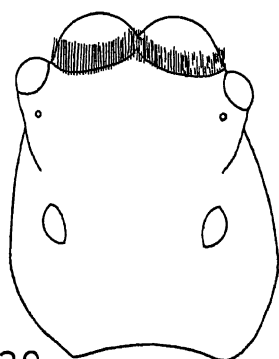
FIGURE 36. Proclaw of third leg.



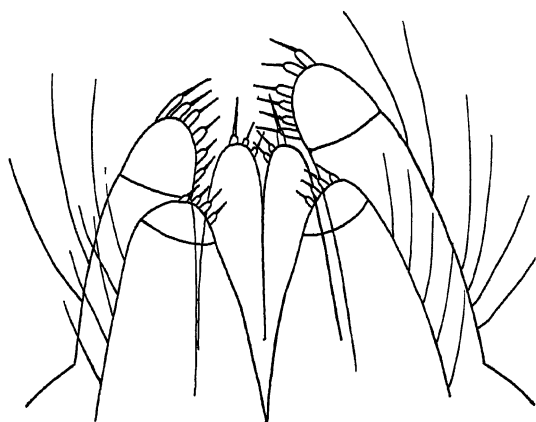
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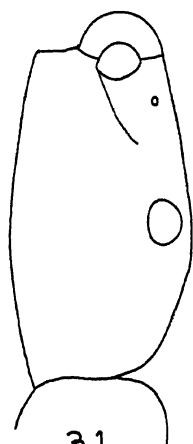
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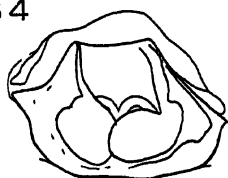


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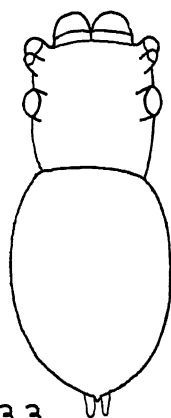
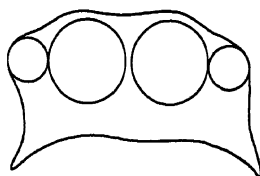


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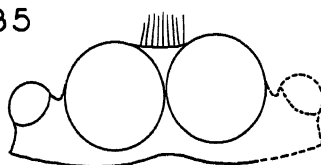


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## PLATE V

FIGURES 37 to 41. *Eolinus succineus* n. g., n. sp. Female. Gynetype. British Museum, Coll. Klebs 520, No. 13478, In. 18762.

FIGURE 37. Eyegroup viewed from above.

FIGURE 38. Side view of carapace showing the four eyes of the right side and three coxae.

FIGURE 39. Front view of carapace showing the face and the carapace as far as visible in this position. The eyes of the second row appear as if they were in contact with the eyes of the third row, but that is only because of the foreshortened drawing.

FIGURE 40. Prolateral view of the end of the first left tarsus showing the claws and the claw-tufts.

FIGURE 41. Epigynum.

FIGURES 42 to 44. *Eolinus succineus* n. g., n. sp. Male. Androtype. British Museum, Coll. A. Théry, No. 29126.

FIGURE 42. Retrolateral view of right palp. Notice the shape of the tibia.

FIGURE 43. Dorsal view of left palp.

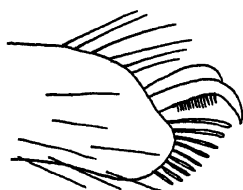
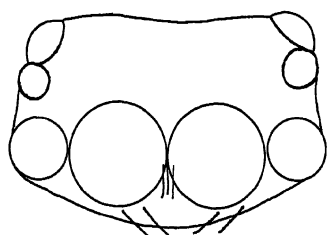
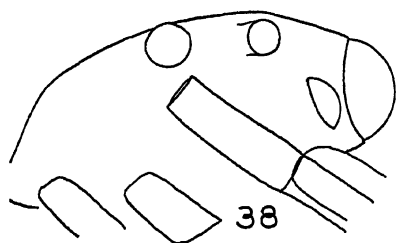
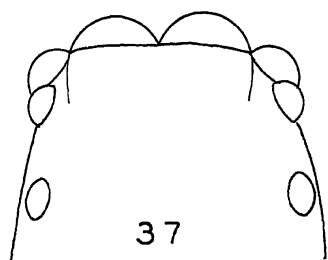
FIGURE 44. Side view of carapace showing the four eyes of the right side.

FIGURES 45 to 47. *Eolinus theryi* n. g., n. sp. Male. Type. British Museum, Coll. A. Théry, No. 29169.

FIGURE 45. Carapace viewed from above.

FIGURE 46. Retrolateral view of right palp. Notice the shape of the tibia.

FIGURE 47. Side view of carapace showing the four eyes of the right side.



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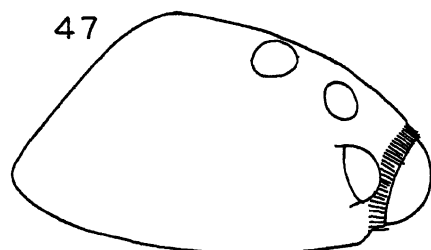
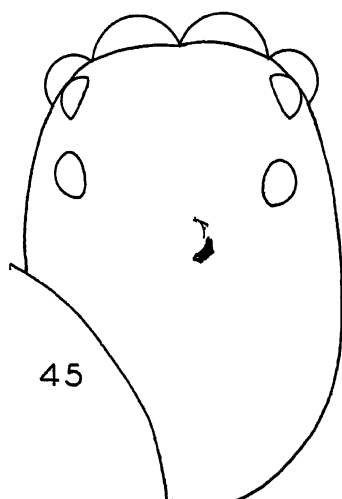
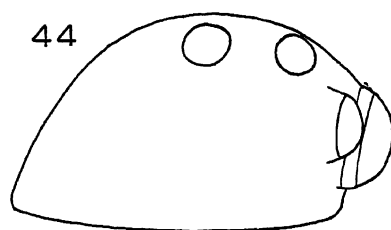
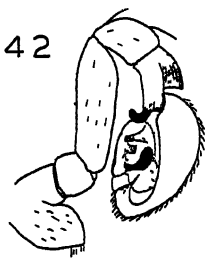
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## PLATE VI

FIGURES 48 and 49. *Gorgopis jucunda* n. g., n. sp. Female. Type. Coll. Klebs 516, No. 3765. British Museum In. 18758.

FIGURE 48. Carapace viewed from above showing eyegroup. The thoracic groove is not visible.

FIGURE 49. Three-quarter view of face and head.

FIGURE 50. *Gorgopis frenata* (Koch and Berendt). Male. Parahypotype. Coll. Klebs 511, No. 13432. British Museum In. 18753. Prolateral view of the claws and claw-tufts of the left fourth tarsus.

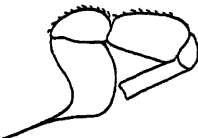
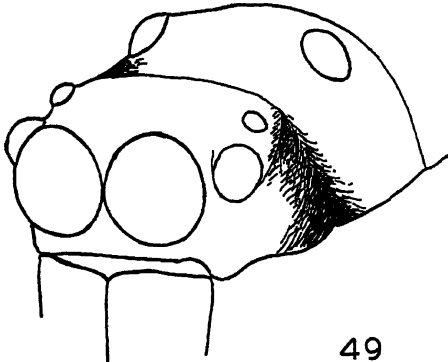
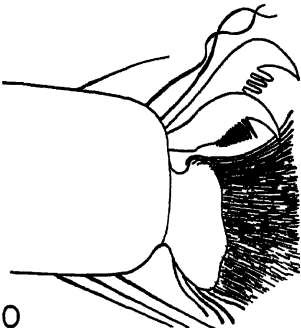
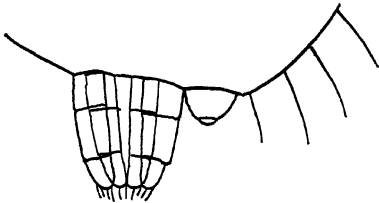
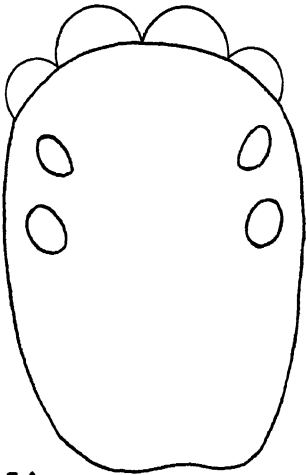
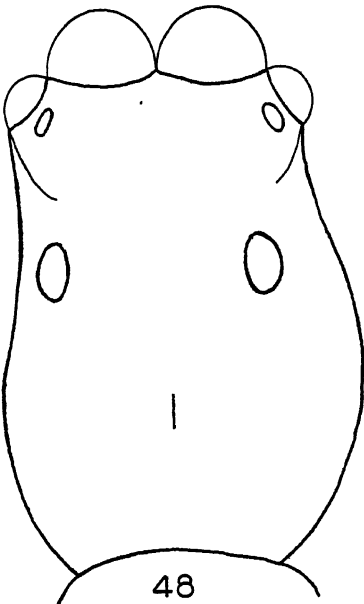
FIGURE 51. *Eolinus theryi* n. sp. Specimen presented by Prof. Th. S. Painter. Dorsal view of carapace.

FIGURES 52 to 54. *Orchestina baltica* n. sp.

FIGURE 52. *Orchestina baltica* n. sp. Female. Gynetype. British Museum, Samland, In. 18137. Spinnerets viewed in transmitted light under high power.

FIGURE 53. *Orchestina baltica* n. sp. Female (?). British Museum, Coll. A. Théry, No. 29132-A. Onychium and one of the claws of the first tarsus.

FIGURE 54. *Orchestina baltica* n. sp. Male. British Museum, Coll. A. Théry, No. 29132-B. Prolateral view of right palp.



## PLATE VII

FIGURES 55 and 56. *Orchestina baltica* n. sp. Male.

FIGURE 55. British Museum, Samland, No. 18138. Type. Left fourth leg with distended femur for jumping.

FIGURE 56. British Museum, Samland, No. 18138. Type. Dorsal view of carapace showing eyegroup, dorsal bristles and posterior declivity.

FIGURES 57 and 58. *Auximus succini* n. sp. Female. Type. British Museum, Coll. Klebs 484, No. 13463, In. 18727.

FIGURE 57. Ventral view of spinnerets with cribellum. All hairs appear thick because of a heavy coating of a white emulsion.

FIGURE 58. Left chelicera from below, showing both margins.

FIGURES 59 and 60. *Dysdera scobiculata* Menge. Immature female. British Museum, Coll. Klebs 527, No. 13431, In. 18769.

FIGURE 59. End of a tarsus showing a claw.

FIGURE 60. Eyegroup viewed from above.

FIGURES 61 to 63. *Archaea paradoxa* Koch and Berendt. Immature female. British Museum, Coll. Klebs 506, No. 13874, In. 18748.

FIGURE 61. Eyegroup viewed from above.

FIGURE 62. Face with chelicerae, viewed from in front.

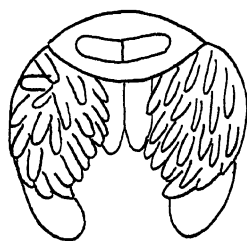
FIGURE 63. Ventral view with legs and palpi omitted.



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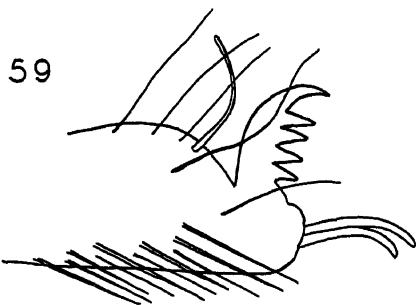
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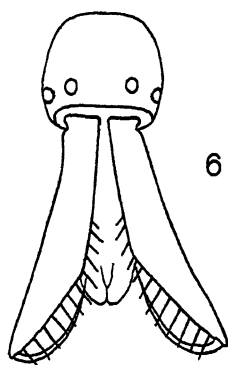
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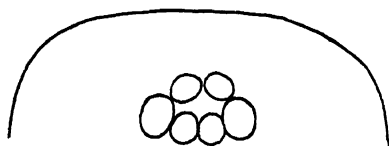
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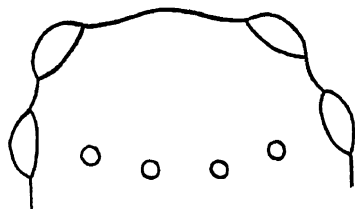
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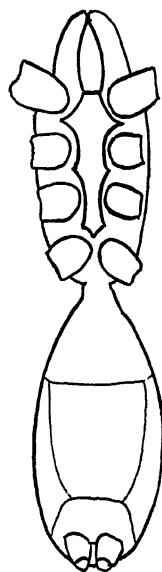
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## PLATE VIII

FIGURES 64 to 68. *Eomatachia latifrons* n. g., n. sp. Male.

FIGURE 64. Type. British Museum, Coll. Klebs 494, No. 13433, In. 18737. Eyegroup of male from above.

FIGURE 65. Type. British Museum, Coll. Klebs 494, No. 13433, In. 18737. Right palp showing tibial apophyses.

FIGURE 66. Type. British Museum, Coll. Klebs 494, No. 13433, In. 18737. Left palp showing tibial apophyses in a slightly different view from figure 65.

FIGURE 67. British Museum, Coll. Klebs 490, No. 13396, In. 18733. Paratype. Lip, maxillae and anterior end of sternum.

FIGURE 68. British Museum, Coll. Klebs 490, No. 13396, In. 18733. Spinnerets with the cribellum in front of them.

FIGURES 69 to 72. *Esuritor spinipes* n. g., n. sp. Pullus.

FIGURE 69. British Museum, Coll. Klebs 476, No. 13400, In. 18718. Paratype. First right leg. Notice the long ventral spines and the row of dorsal trichobothria.

FIGURE 70. British Museum, Coll. Klebs 503, No. 13401, In. 18745. Type. Eyegroup viewed from above.

FIGURE 71. British Museum, Coll. Klebs 503, No. 13401, In. 18745. Type. View of face.

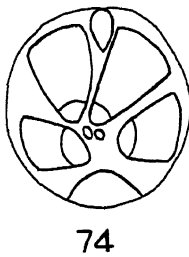
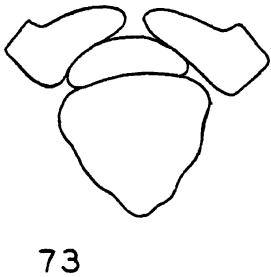
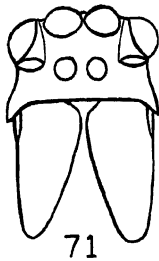
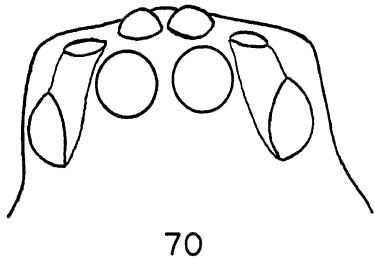
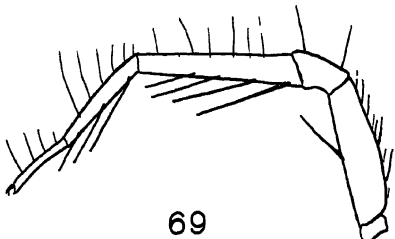
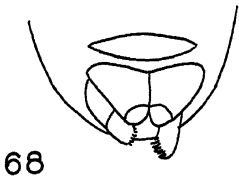
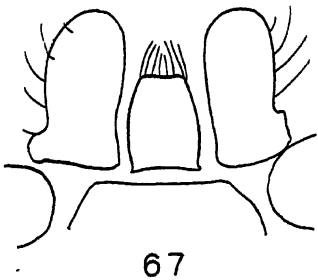
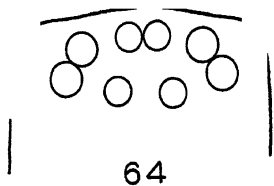
FIGURE 72. British Museum, Coll. Klebs 476, No. 13400, In. 18718. Paratype. First right tarsus showing one of the upper claws and the third claw.

FIGURES 73 to 75. *Municeps pulcher* n. g., n. sp. Pullus. Type. British Museum, Seebohm's bequest, No. 17660.

FIGURE 73. Lip, maxillae and sternum.

FIGURE 74. Spinnerets. Notice the colulus in front of the anterior spinnerets.

FIGURE 75. End of a tarsus with claws. Notice a spurious claw.





## PLATE IX

FIGURES 76 to 82. *Acrometa cristata* n. g., n. sp. Male.

FIGURE 76. British Museum, Coll. Klebs 510, No. 13461, In. 18752. Paratype. Carapace from above showing crest of bristles.

FIGURE 77. British Museum, Coll. Klebs 481, No. 13408, In. 18724. Type. Right chelicera showing promargin.

FIGURE 78. British Museum, Coll. Klebs 485, No. 13458, In. 18728. Paratype. Spinnerets. Notice the colulus. The vertical line is the edge of a femur obstructing the view of the spinnerets.

FIGURE 79. British Museum, Coll. Klebs 467, No. 13430, In. 18713. Paratype. Eyegroup from above.

FIGURE 80. British Museum, Coll. Klebs 510, No. 13461, In. 18752. Paratype. Left palp viewed from the underside of the slide.

FIGURE 81. British Museum, Coll. Klebs 467, No. 13430, In. 18713. Paratype. Front view of left palp.

FIGURE 82. British Museum, Coll. Klebs 508, No. 13453, In. 18750. Paratype. Sternum, lip, maxillae and fangs.

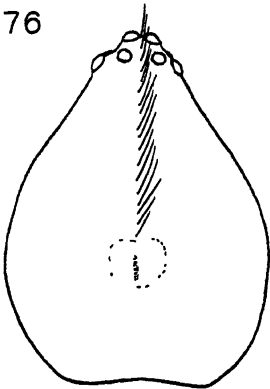
FIGURES 83 to 85. *Malleator niger* n. g., n. sp. Male. Type. British Museum, Samland, In. 18944. These three figures are drawn to the same scale to emphasize the size of the palp.

FIGURE 83. Right palp.

FIGURE 84. Side view of carapace.

FIGURE 85. Carapace viewed from above. Notice the eye turret and the shoulder humps.

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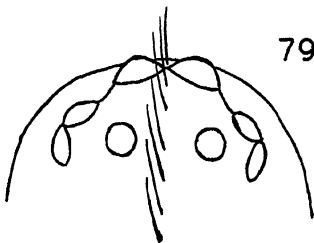
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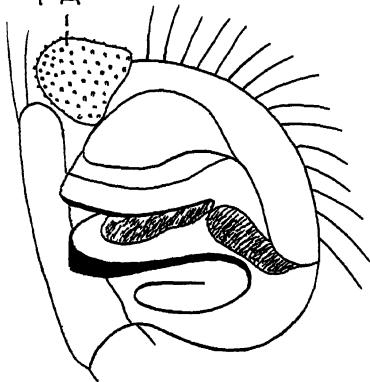
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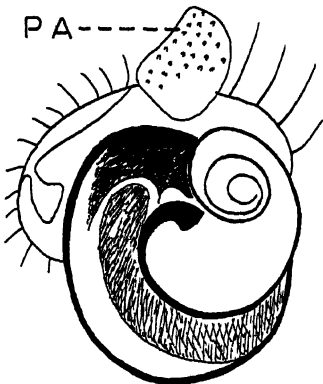


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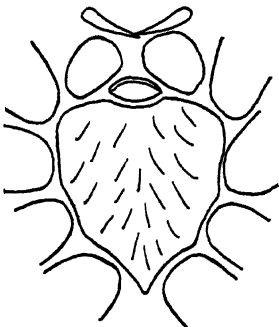


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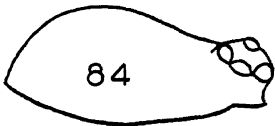
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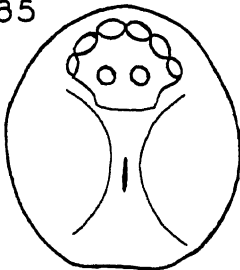


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## PLATE X

FIGURES 86 to 90. *Anniculus balticus* n. g., n. sp. Female. Type. British Museum, Coll. Klebs 507, No. 13435, In. 18749.

FIGURE 86. Carapace viewed from above.

FIGURE 87. A piece of a leg viewed under high power in reflected light, showing plumose hair.

FIGURE 88. Sternum, lip and maxillae.

FIGURE 89. Petiolus viewed from above. Notice the anterior piece of the lorum emarginate at both ends.

FIGURE 90. The two spinnerets on a common pedestal.

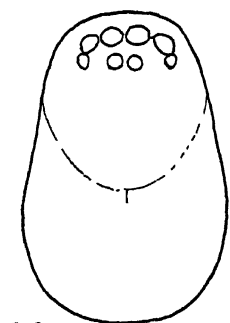
FIGURES 91 to 94. *Ero permunda* n. sp. Type. British Museum, Coll. Klebs 502, No. 13462, In. 18744.

FIGURE 91. Side view of spider with legs omitted.

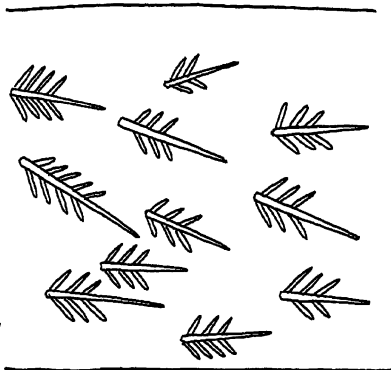
FIGURE 92. First left metatarsus showing all prolateral spines.

FIGURE 93. Left palp.

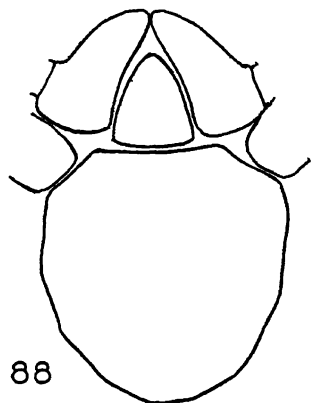
FIGURE 94. Dorsal view of eyegroup and chelicerae.



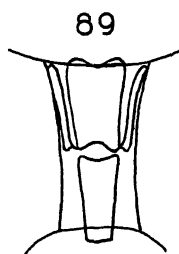
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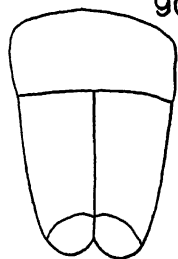
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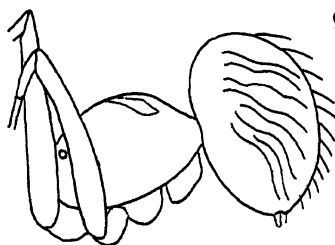
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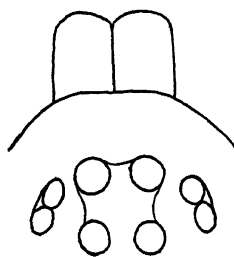
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## PLATE XI

FIGURES 95 to 100. *Adorator brevipes* n. g., n. sp. Male. Type. British Museum, Coll. Klebs 474, No. 13455, In. 18716.

FIGURE 95. Carapace viewed from above showing thoracic groove, outline of head and entire eyegroup

FIGURE 96. Eyegroup viewed from above

FIGURE 97. Front view of face.

FIGURE 98. Spinnerets, colulus and anal tubercle. Notice that the median spinnerets are in a transverse row in line with the posterior pair.

FIGURE 99. Dorsal view of right palp. Notice blunt tibial apophysis.

FIGURE 100. Left fourth tarsus showing one upper claw and the thorn-like third claw.

FIGURES 101 and 102. *Adorator samlandicus* n. sp. Male. Type. British Museum, Samland, In. 18144.

FIGURE 101. Right palp. Notice the tibial apophysis and the scoop-like structure of the copulatory apparatus

FIGURE 102. Right fourth retroclaw.

FIGURES 103 to 105. *Theridiometa edwardsi* n. g., n. sp. Female. Type. British Museum, Coll. W. N. Edwards, In. 18964.

FIGURE 103. Tarsal claws.

FIGURE 104. Epigynum.

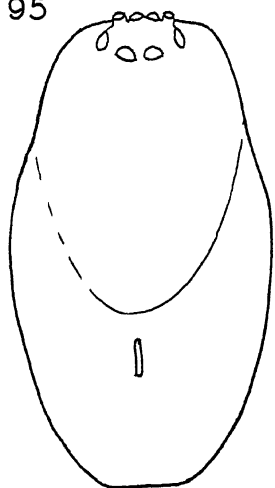
FIGURE 105. Right chelicera viewed from below, greatly foreshortened, and right maxilla.

FIGURES 106 and 107. *Theridiometa edwardsi* n. sp. Female. Paratype. British Museum, Coll. Klebs, No. 13417, In. 18768.

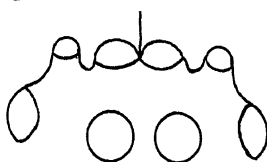
FIGURE 106. Carapace viewed from above showing entire eyegroup and outline of head.

FIGURE 107. First left patella viewed from above.

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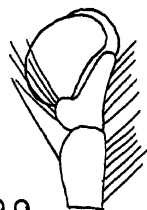
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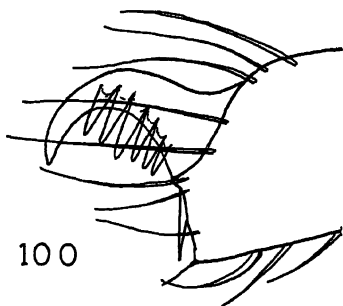
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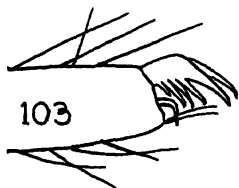
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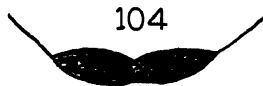
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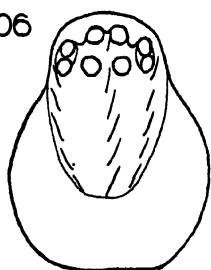


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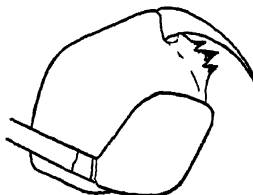


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TIBIA

FEMUR



## PLATE XII

FIGURES 108 to 111. *Ero carboneana* n. sp. Male. Type. Coll. Klebs 513, No. 13398. British Museum In. 18755.

FIGURE 108. Carapace viewed from above. Circular thoracic depression indicated by dotted line.

FIGURE 109. Face and sternum viewed from the right side.

FIGURE 110. Front view of face.

FIGURE 111. Left palp viewed from outside.

FIGURES 112 to 116. *Eluctus inermis* n. g., n. sp. Male. Type. Coll. Klebs 501, No. 13441. British Museum In. 18743.

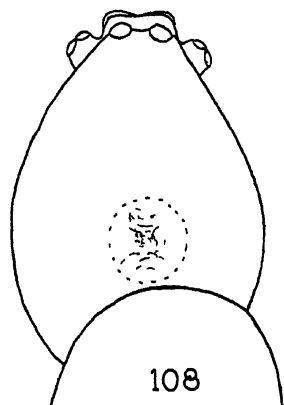
FIGURE 112. Carapace viewed from above.

FIGURE 113. Colulus, spinnerets and anal tubercle.

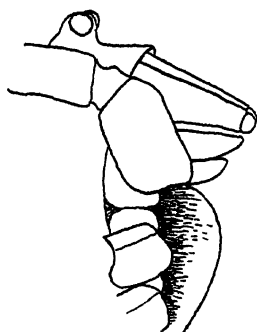
FIGURE 114. Front view of face.

FIGURE 115. Left palp viewed from outside.

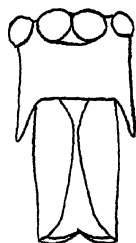
FIGURE 116. End of a tarsus showing one of the upper claws, third claw and two spurious claws.



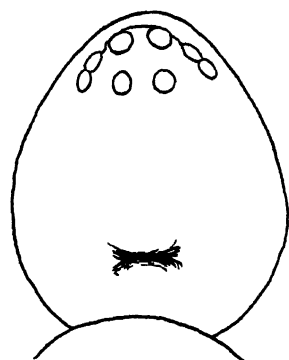
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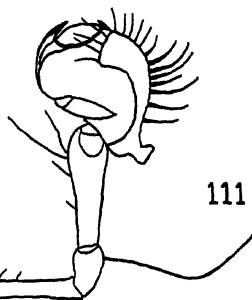
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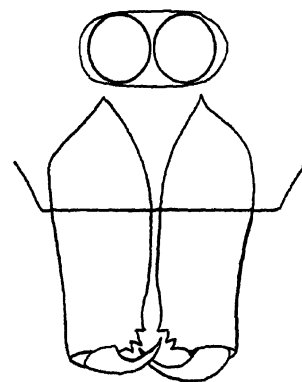
112



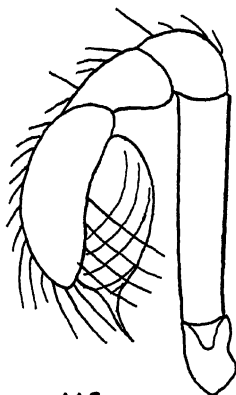
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### PLATE XIII

FIGURES 117 to 123. *Eustaloides succini* n. sp. Male. Type. British Museum, Coll. Klebs 522, No. 13438, In. 18764.

FIGURE 117. Maxillae, lip and sternum. Notice the outer angle of the maxillae.

FIGURE 118. Retrolateral view of second right leg showing arrangement and relative size of spines on tibia and patella.

FIGURE 119. Special hooked hair on ventral surface of tarsus. The common hair is also shown in its relative position.

FIGURE 120. Left palp viewed from below. Embolus has the shape of a long, fine needle.

FIGURE 121. Prolateral view of left palp.

FIGURE 122. One of the two upper claws and the third claw of a tarsus.

FIGURE 123. Dorsal view of eyegroup with the anterior edge of the carapace.

FIGURES 124 to 128. *Segestria elongata* (Koch and Berendt). Female. British Museum, Coll. Klebs 493, No. 13415, In. 18736.

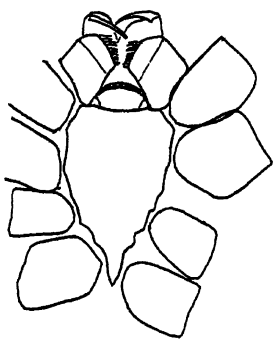
FIGURE 124. Front view of face showing entire eyegroup with clypeus and chelicerae.

FIGURE 125. Carapace from above.

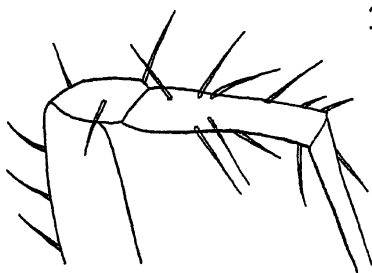
FIGURE 126. Palpal claw.

FIGURE 127. Proclaw of second right leg viewed from the prolateral side.

FIGURE 128. Retroclaw and third claw of second right leg viewed from the retrolateral side.



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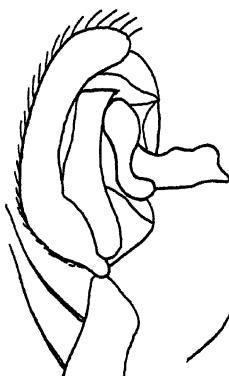


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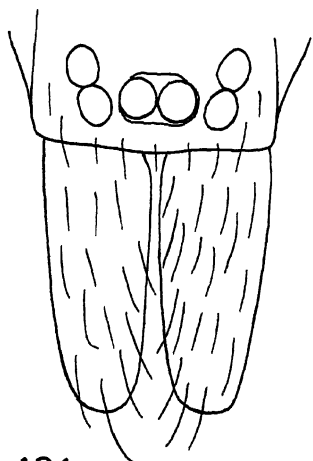
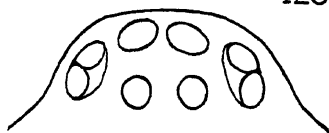
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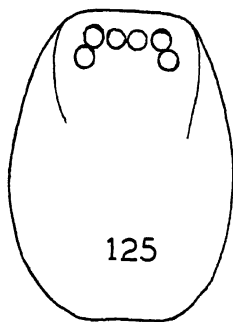
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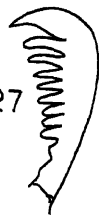


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## PLATE XIV

FIGURES 129 to 135. **Custodela cheiracantha** (Koch and Berendt). Male. Hypotype. British Museum, Coll. Klebs 523, No. 13425, In. 18765.

FIGURE 129. Carapace viewed from above.

FIGURE 130. Right chelicera as seen from in front.

FIGURE 131. Face showing entire eyegroup and clypeus.

FIGURE 132. End of second left tarsus showing the claws.

FIGURE 133. Lateral view of carapace. Notice the relative length of the chelicerae.

FIGURE 134. Left palp viewed from the outside.

FIGURE 135. Right palp viewed from in front, showing its dorsal aspect. Notice the curved paracymbium (PA).

FIGURES 136 to 139. **Captrix lineata** (Koch and Berendt). Female. Hypotype. British Museum, Coll. Klebs 525, No. 13439, In. 18767.

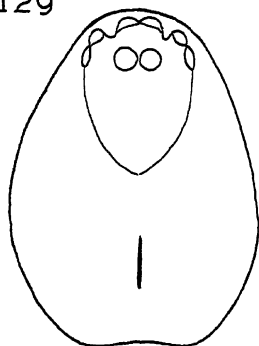
FIGURE 136. Epigynum viewed in a combination of transmitted and reflected light.

FIGURE 137. Eyegroup viewed from above.

FIGURE 138. Proclaw of third left tarsus.

FIGURE 139. Sternum, maxillae, lip and coxae. Notice the oblique depressions on the maxillae, indicated by shading.

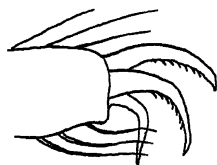
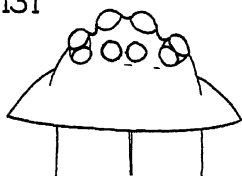
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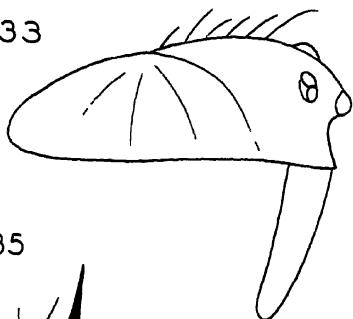


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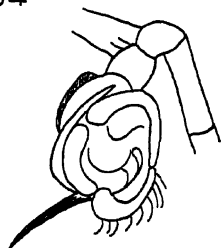


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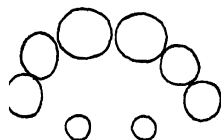
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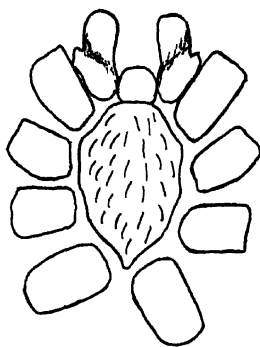
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## PLATE XV

FIGURES 140 to 147. *Massula klebsi* n. g., n. sp. Male. Androtype. British Museum, Coll. Klebs 504, No. 13486, In. 18746.

FIGURE 140. View of the body of the spider from above. The dorsal portions are drawn in heavier lines and show the outline of the carapace with the entire eyegroup and thoracic groove, the petiolus and the abdomen with the spinnerets. Through the transparent carapace the sternum is visible with the five pairs of coxae and the end of the rostrum (pharynx). In front of the semicircular edge the two cavities leading into the chelicerae are visible under the eyegroup.

FIGURE 141. Face showing eyegroup, clypeus and chelicerae with boss and promarginal scopula.

FIGURE 142. Right palp in prolateral view. The retrolateral tibial apophysis is not visible in this position of the palp.

FIGURE 143. A tarsal claw.

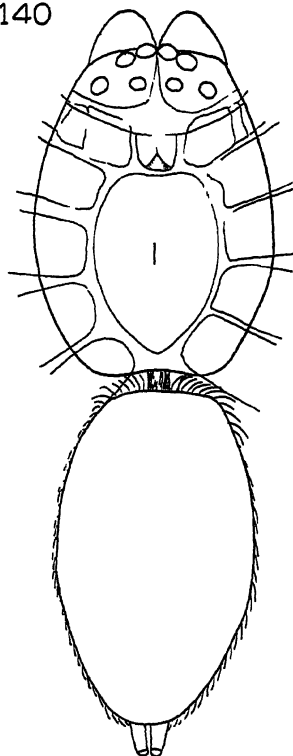
FIGURE 144. The end of a metatarsus with the terminal, dorsal membrane.

FIGURE 145. Anal tubercle and spinnerets in side view.

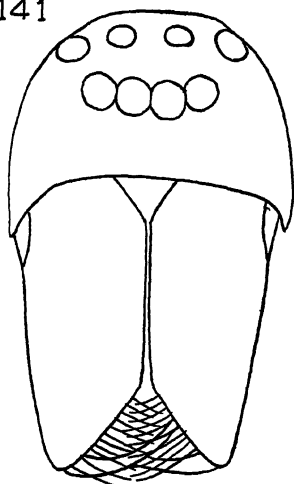
FIGURE 146. Ventral view of chelicerae, maxillae and lip. The promarginal cheliceral scopulae are not shown, so as not to obstruct the view of fangs and the three retromarginal teeth of the right chelicera. The teeth of the left chelicera are hidden from view by the fang.

FIGURE 147. The six spinnerets viewed from below.

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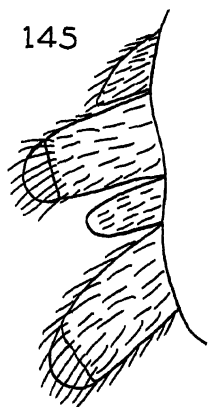
142



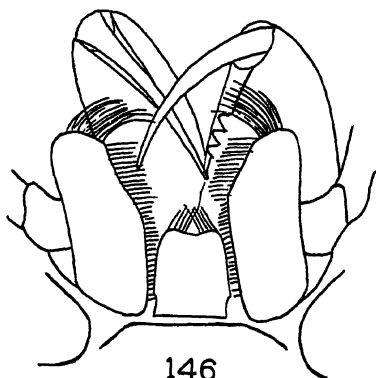
143



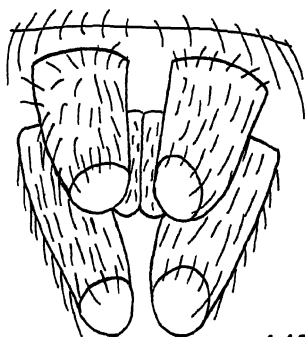
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## PLATE XVI

FIGURES 148 to 154. *Collacteus captivus* n. g., n. sp. Female. Type. British Museum, Coll. Klebs 472, No. 13414, In. 18714.

FIGURE 148. Eyegroup viewed from above.

FIGURE 149. Palpal claw.

FIGURE 150. Front view of face.

FIGURE 151. First left proclaw.

FIGURE 152. Right chelicera showing the promarginal scopula and the retro-marginal teeth.

FIGURE 153. Maxillae, lip and anterior edge of sternum.

FIGURE 154. First left metatarsus and tarsus showing the scopulae and the trichobothria. The hair on the dorsal surface is omitted from the drawing so as not to obstruct the view of the trichobothria.

FIGURES 155 to 159. *Abbiguritor niger* n. g., n. sp. Male. Type. British Museum, Samland, In. 18119.

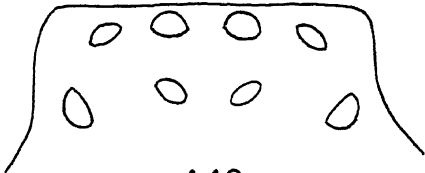
FIGURE 155. Right palp viewed from the outside. Notice the tibial apophysis (AP).

FIGURE 156. Left palp viewed from the inside. Notice the outer angle of the maxilla, the curvature of the femur and the needle-like embolus.

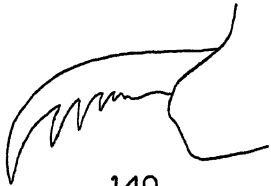
FIGURE 157. Carapace viewed from above showing the entire eyegroup and the thoracic groove.

FIGURE 158. One of the two tarsal claws and the claw-tufts. The other claw is omitted from the drawing.

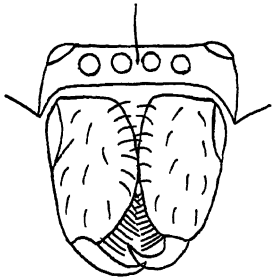
FIGURE 159. Sternum, lip, maxillae and coxae.



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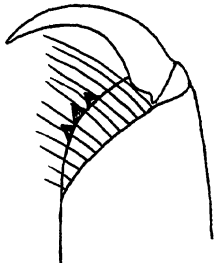
149



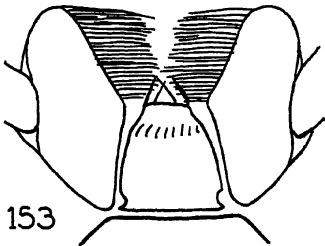
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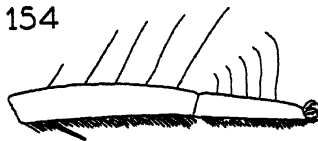
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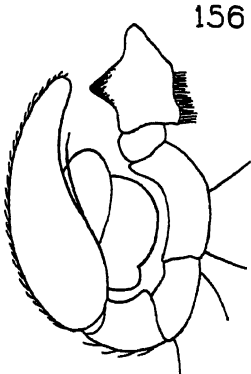
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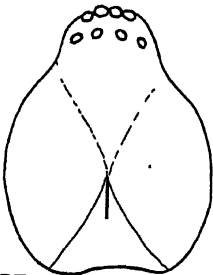
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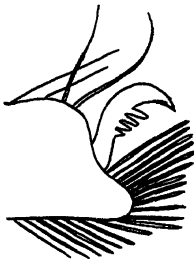
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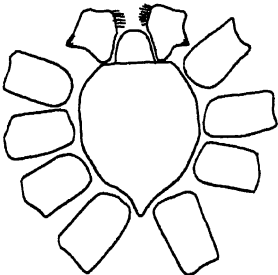
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## PLATE XVII

FIGURES 160 to 168. *Eodipoena oculata* n. g., n. sp. Female. Type. British Museum, Coll. Klebs 498, No. 13448, In. 18740.

FIGURE 160. Dorsal view of carapace with eyegroup.

FIGURE 161. Front view of face showing clypeus and eyegroup. The latter is foreshortened in the drawing.

FIGURE 162. Side view. Notice epigynum.

FIGURE 163. Eyegroup viewed from above.

FIGURE 164. Epigynum.

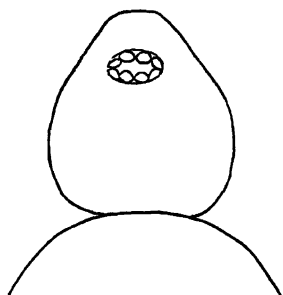
FIGURE 165. Left fourth tarsus showing the comb.

FIGURE 166. Second left proclaw.

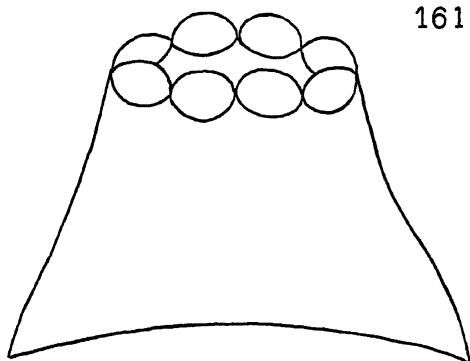
FIGURE 167. Club-shaped hair on a tarsus.

FIGURE 168. Second left retroclaw, third claw and a spurious claw.

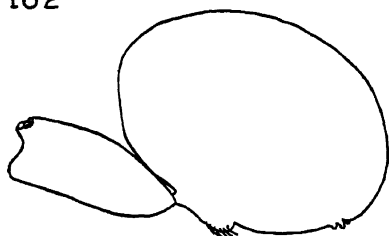
160



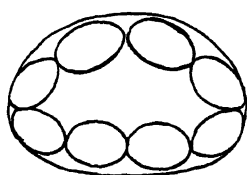
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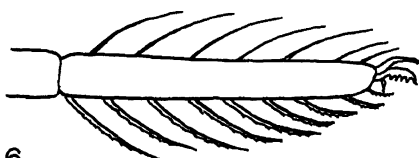
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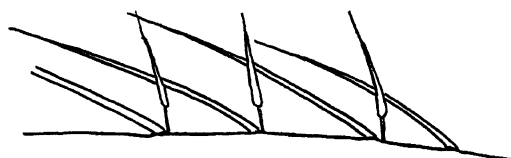


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## PLATE XVIII

FIGURES 169 to 176. *Spatiator praeceps* n. g., n. sp. Female. Gynetype. British Museum, Coll. Klebs 518, No. 3761, In. 18760.

FIGURE 169. Carapace viewed from above, showing head and eyegroup. Right posterior median eye is not visible owing to poor preservation and is indicated by a dotted line.

FIGURE 170. Lateral view of abdomen. Notice plications possibly representing remnants of segmentation.

FIGURE 171. Claws of third left tarsus. Notice finely serrated bristles under the claws.

FIGURE 172. Second left leg showing relative proportions of its segments. Notice unusual shape and length of patella.

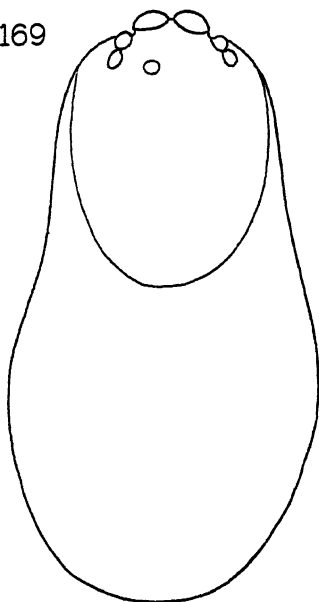
FIGURE 173. Petiolus viewed from above. The anterior curve represents the edge of the carapace.

FIGURE 174. Group of spinnerets and anal tubercle. The curved line above the group is the last abdominal plication.

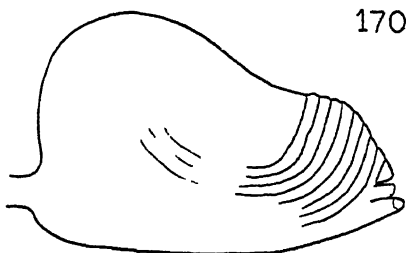
FIGURE 175. Carapace viewed from the left side.

FIGURE 176. Spatulate hairs on the ventral surface of the second metatarsus forming the scopula.

169



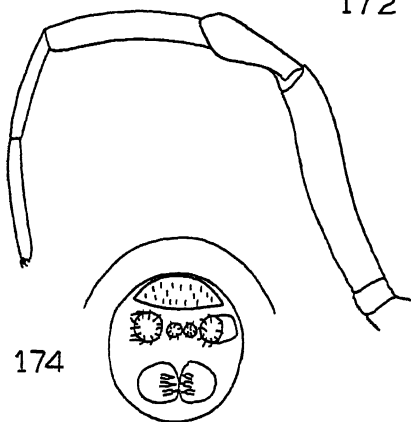
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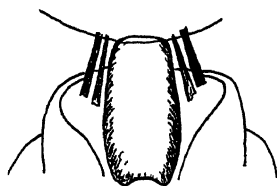


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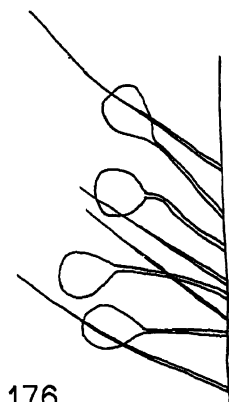


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## PLATE XIX

FIGURES 177 to 185. *Spatiator praeceps* n. g., n. sp. Male. Androtype. British Museum, Coll. Klebs 519, No. 3764, In. 18761.

FIGURE 177. Carapace viewed from above, showing head and entire eyegroup, as well as the petiolus.

FIGURE 178. Maxillae, lip, sternum and coxae.

FIGURE 179. Carapace viewed from the left side.

FIGURE 180. Front view of face, showing entire eyegroup, clypeus and chelicerae. Notice the two pointed retromarginal teeth of the chelicerae.

FIGURE 181. Spinnerets in side view. The small median spinneret is visible through the posterior spinneret.

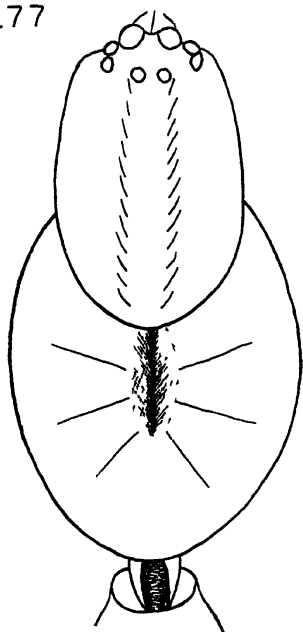
FIGURE 182. Left palp viewed from outside.

FIGURE 183. Femur of right palp viewed from inside.

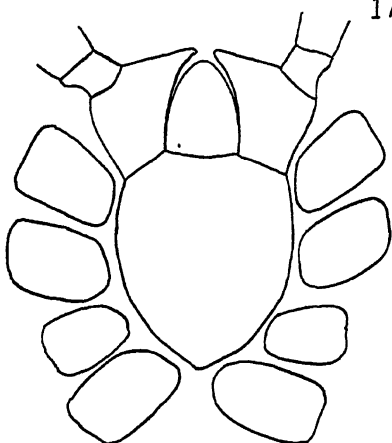
FIGURE 184. Second left tarsus showing arrangement and relative length of hair.

FIGURE 185. Fourth left tarsus showing claws.

177



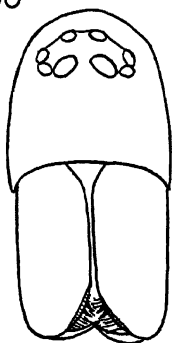
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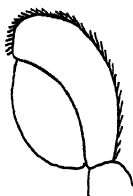
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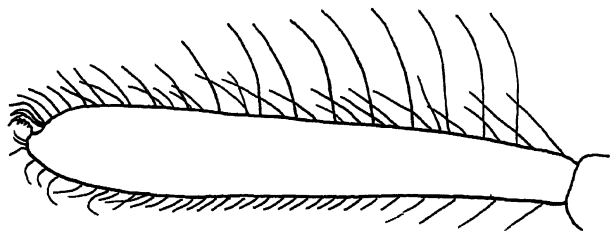
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PLATE XX

FIGURES 186 to 192. *Insecutor aculeatus* n. g., n. sp. Immature female. Type. Coll. Klebs 499, No. 13465. British Museum In. 18741.

FIGURE 186. Carapace viewed from above.

FIGURE 187. Eyegroup viewed from in front. The edge of the clypeus is indicated by the horizontal line.

FIGURE 188. Lip and maxillae under high power.

FIGURE 189. Sternum and coxae.

FIGURE 190. Third left metatarsus showing peculiar hairs having the shape of hooks.

FIGURE 191. First right tibia and patella showing arrangement and relative length of spines and the tibial and metatarsal trichobothria.

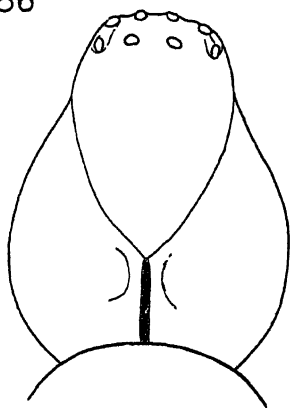
FIGURE 192. End of a tarsus with one of the upper claws and the third claw.

FIGURES 193 and 194. *Desultor depressus* n. g., n. sp. Male. Type. Coll. Klebs 514, No. 13411. British Museum In. 18756.

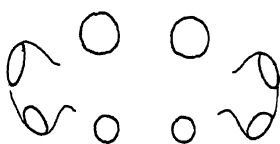
FIGURE 193. Right palp viewed from above. Notice the tooth at the end of the tibial apophysis.

FIGURE 194. Right palp viewed from below.

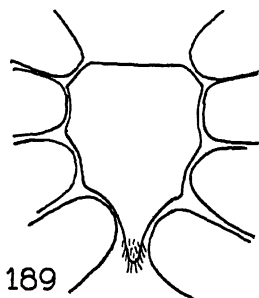
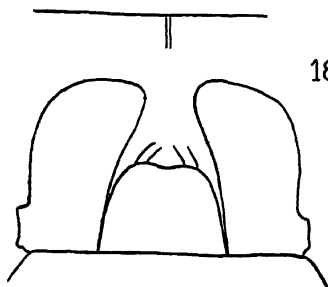
186



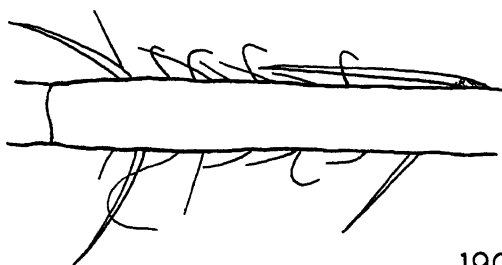
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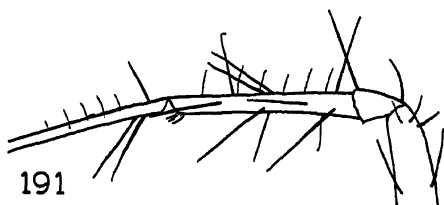


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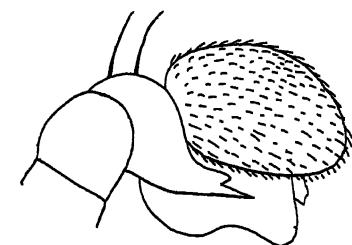
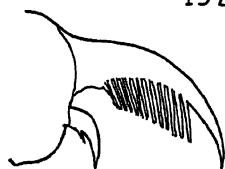


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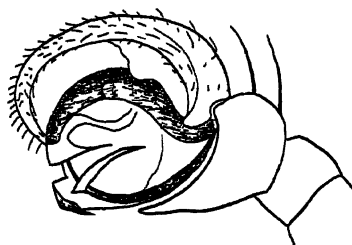
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194



## PLATE XXI

FIGURES 195 to 201. *Adamator succineus* n. g., n. sp. Female. Type. British Museum, Coll. Klebs 486, No. 13404, In. 18729.

FIGURE 195. Sternum, coxae, maxillae and lip.

FIGURE 196. Edge of carapace viewed from above in transmitted light. Notice the spurs, one opposite each coxal foramen. These spurs are on the edge of the carapace, which is turned under. Only the second and third coxae are shown. MA—lateral margin of carapace. VE—ventral edge of carapace. OC—opening of coxa into the thoracic cavity. ST—edge of sternum.

FIGURE 197. One of the tarsal claws.

FIGURE 198. Dorsal view of anal tubercle and upper spinnerets. Notice the spinning tubes.

FIGURE 199. Eyegroup viewed from above.

FIGURE 200. Spinnerets and anal tubercle viewed from below.

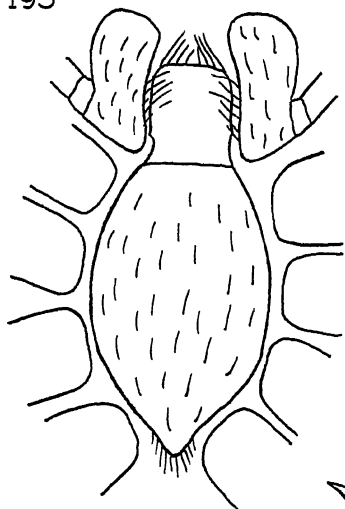
FIGURE 201. End of second metatarsus and base of tarsus. Notice the metatarsal end-membrane, the flat hairs of the scopulae and the arrangement of hair on the metatarsus.

FIGURES 202 and 203. *Collacteus captivus* n. g., n. sp. Female. Type. British Museum, Coll. Klebs 472, No. 13414, In. 18714.

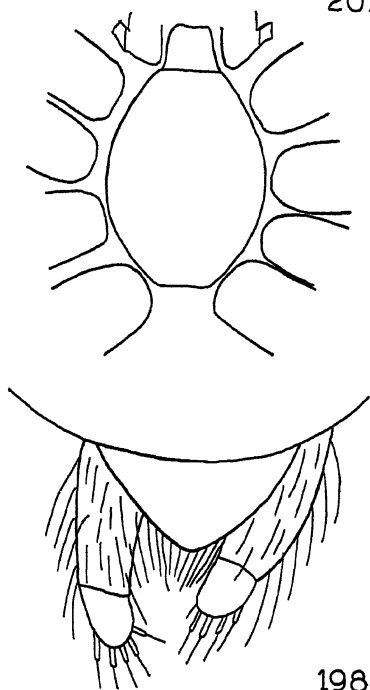
FIGURE 202. Sternum, lip and coxae.

FIGURE 203. Spinnerets and anal tubercle viewed from behind.

195



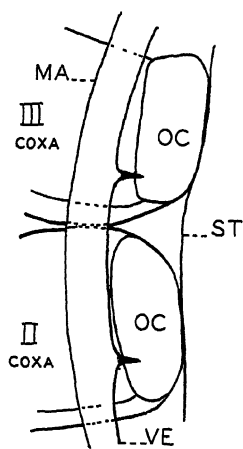
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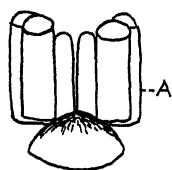
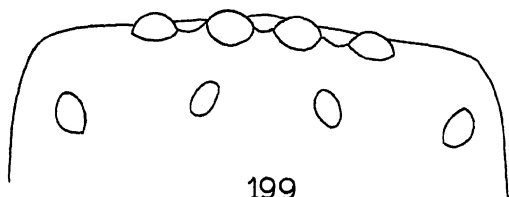
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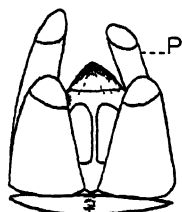
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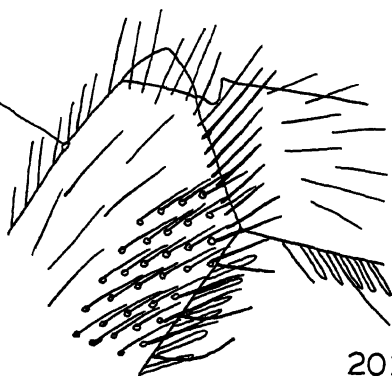
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## PLATE XXII

FIGURES 204 to 211. *Adulatrix fusca* n. g., n. sp.

FIGURES 204 to 207. Immature female. Type. British Museum, Coll. Klebs 491, No. 13412, In. 18734.

FIGURES 208 to 211. Female. Paratype. British Museum, Coll. Klebs 483, No. 13406, In. 18726.

FIGURE 204. Eyegroup viewed from above.

FIGURE 205. Front view of face showing chelicerae, clypeus and eyes. In this view the posterior lateral eyes appear as if they were in the same row with the anterior eyes. Notice the boss of the chelicerae, the promarginal scopula and the fairly short fangs.

FIGURE 206. Dorsal view of carapace and abdomen.

FIGURE 207. Scopular hairs of the second tarsus. Notice the presence of sculpturing on the hair.

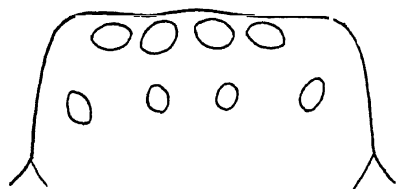
FIGURE 208. Left chelicera and maxilla viewed from below. Notice the three retromarginal teeth and the little sclerite under the fang.

FIGURE 209. Sternum, lip, maxillae and coxae.

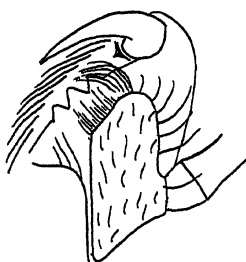
FIGURE 210. Eyegroup viewed from above.

FIGURE 211. End of second tarsus showing one of the claws, claw-tufts and scopula with a row of longer hairs protruding at intervals.

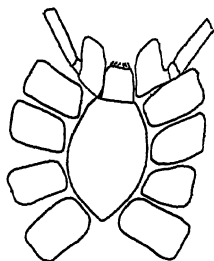
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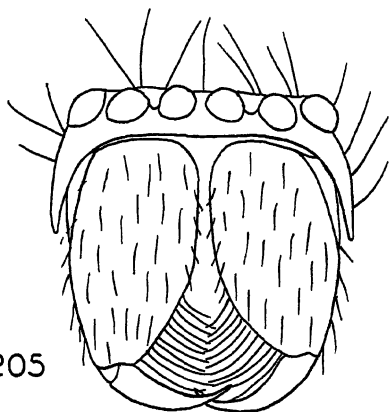
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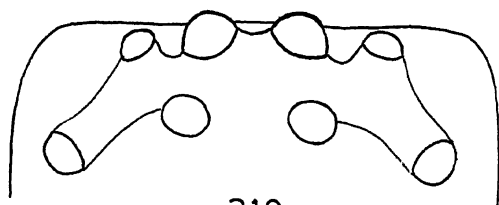
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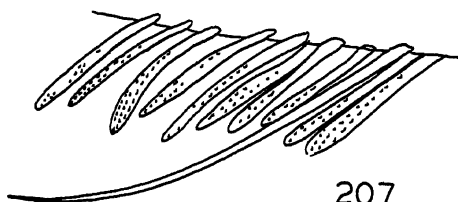
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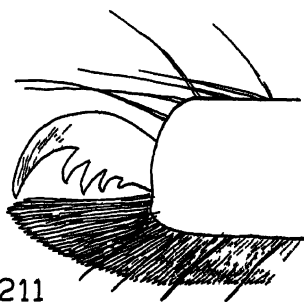
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211



## PLATE XXIII

FIGURES 212 to 218. *Memoratrix rydei* n. g., n. sp. Female. Type. British Museum, Coll. C. Ryde, In. 27369.

FIGURE 212. View of the spider from the left side to show the relative size of the carapace, abdomen and first leg. The second and third legs are omitted from the drawing although present in the spider. The missing tibia of the fourth leg is indicated by a dotted line. Notice the prominent epigynum.

FIGURE 213. Lateral view of face and base of first right leg.

FIGURE 214. Carapace viewed from above showing the outline of the head, the thoracic groove and the posterior declivity.

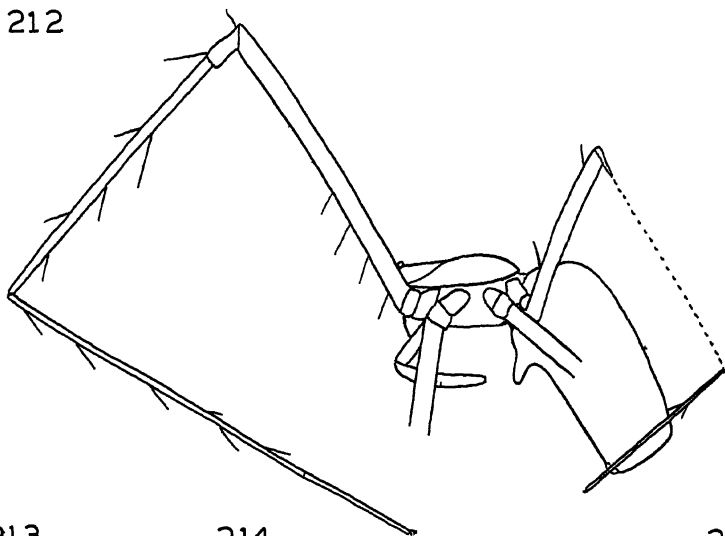
FIGURE 215. Front view of face.

FIGURE 216. Retrolateral view of the end of the first left tarsus showing the retrolateral upper claw and the third claw.

FIGURE 217. Basal portion of the right third femur showing the three ventral bristles, one dorsal spine and the short hair with which the surface is clothed.

FIGURE 218. Dorsal view of eyegroup when all eyes are in focus. Notice that in this position the head appears wider than the eyegroup. Compare this figure with figure 214.

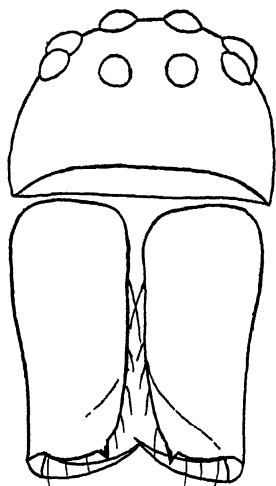
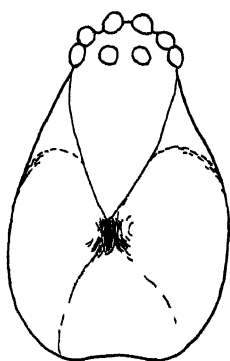
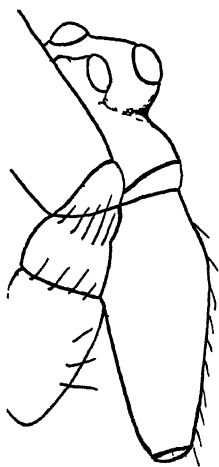
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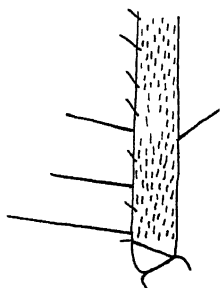
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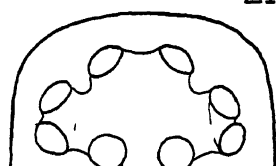


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## PLATE XXIV

FIGURES 219 to 222 *Ablator triguttatus* (Koch and Berendt). Male. British Museum, Coll. Klebs 524, No. 13409, In. 18766.

FIGURE 219. Dorsal view of carapace.

FIGURE 220. Dorsal view of eyegroup.

FIGURE 221. Tibia of right palp, retrolateral view. Notice the apophysis.

FIGURE 222. A group of scales on the back of the abdomen.

FIGURES 223 to 228. *Ablator triguttatus* (Koch and Berendt). Male. Hypotype. British Museum, Coll. Klebs 509, No. 13426, In. 18751.

FIGURE 223. End of second tarsus showing one of the claws and the claw-tufts of one side.

FIGURE 224. Sternum, lip, coxae and left maxilla. The view of the right maxilla is obstructed by the right palp and is omitted from the drawing.

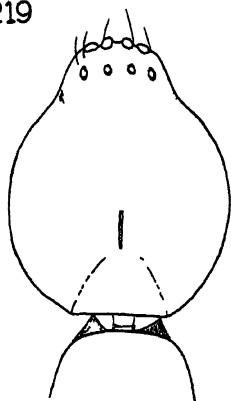
FIGURE 225. Prolateral view of left palp. Notice the curved femur, the three hooks and the embolus. The tibial apophysis is not visible in this position.

FIGURE 226. Retrolateral view of left palp. Notice the three hooks. The rest of the palp is not visible in this position.

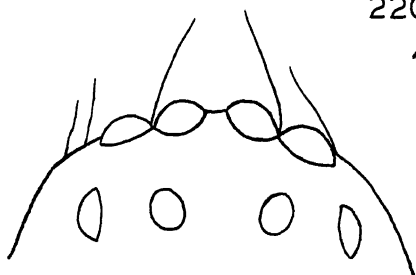
FIGURE 227. The spinnerets. Notice how much stouter are the anterior spinnerets. The median spinnerets are barely visible.

FIGURE 228. Dorsal view of the tibia of the right palp showing the apophysis. Comparison with figure 221 shows that the apophysis is flat.

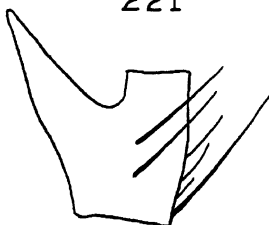
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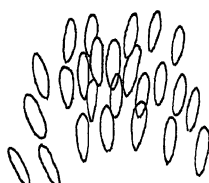
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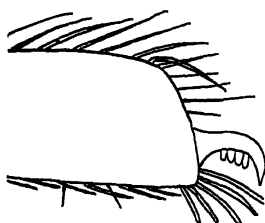
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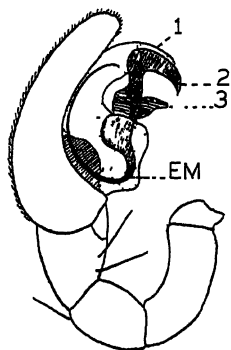
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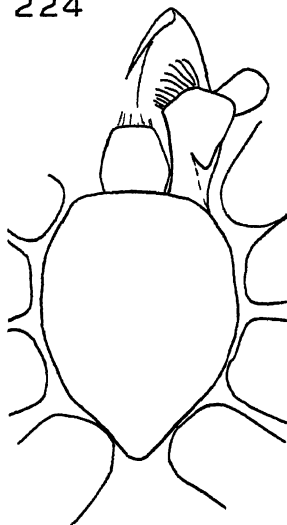
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## PLATE XXV

FIGURES 229 and 230. *Adulatrix decumana* (Koch and Berendt). Female. British Museum, Coll. Klebs 512, No. 13402, In. 18754.

FIGURE 229. Dorsal view of eyegroup.

FIGURE 230. One of the serrated bristles at the end of the fourth left tarsus.

FIGURE 231. *Adamator succineus* n. g., n. sp. Female. Type. British Museum, Coll. Klebs 486, No. 13404, In. 18729. Metatarsus and tarsus of fourth left leg showing the calamistrum (CA).

FIGURE 232. *Adorator samlandicus* n. g., n. sp. Male. Type. British Museum, Samland, In. 18144. Sternum, lip, maxillae and coxae.

FIGURE 233. *Orchestina baltica* n. sp. Lateral view of Male. British Museum, Coll. A. Théry, No. 29124-B.

FIGURE 234. *Orchestina baltica* n. sp. British Museum, Samland, In. 18138. Male. Type. Front view of face.

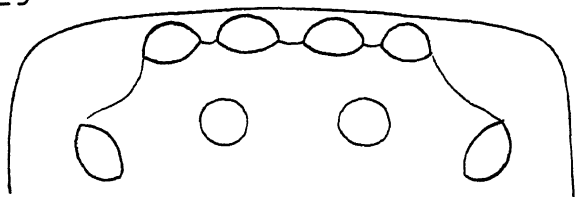
FIGURES 235 to 237. *Orchestina baltica* n. sp. Male. Coll. A. Théry, No. 29124-A, British Museum

FIGURE 235. First left leg.

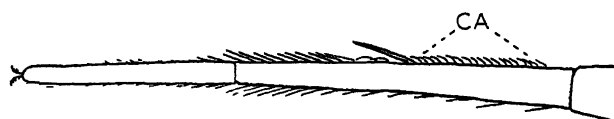
FIGURE 236. Fourth right leg drawn to the same scale as figure 235.

FIGURE 237. Sternum, lip and coxae.

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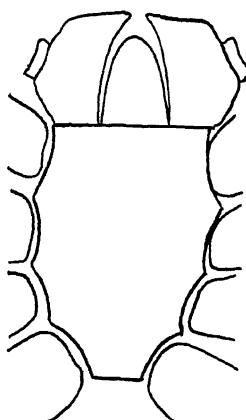


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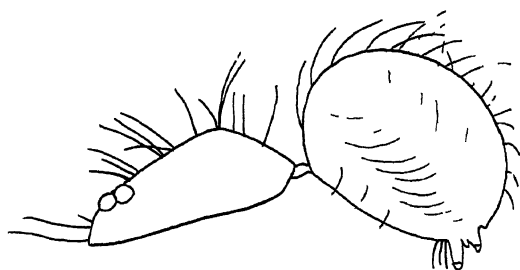


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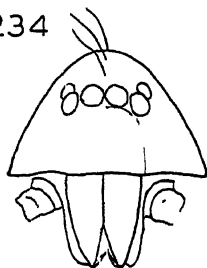
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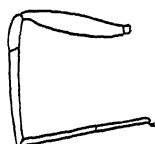
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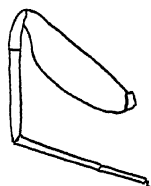
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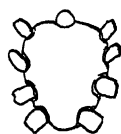


PLATE XXVI

FIGURES 238 to 245. *Insecutor mandibulatus* n. g., n. sp. Female.  
Type. British Museum, Coll. Klebs 500, No. 13456, In. 18742.

FIGURE 238. Front view of face showing eyes on high tubercles, clypeus, chelicerae with open fangs. Notice the shape of the latter and the promarginal scopula with the distal bristle especially stout.

FIGURE 239. Carapace viewed almost, but not quite in profile.

FIGURE 240. Carapace viewed from above.

FIGURE 241. Sternum and coxae. Lip and maxillae are not visible.

FIGURE 242. Second left patella, tibia and metatarsus showing arrangement and relative length of spines.

FIGURE 243. Fourth retroclaw.

FIGURE 244. End of second leg showing proclaw, third claw and one finely serrated bristle.

FIGURE 245. Femur of third leg showing dorsal spines and ventral bristles.

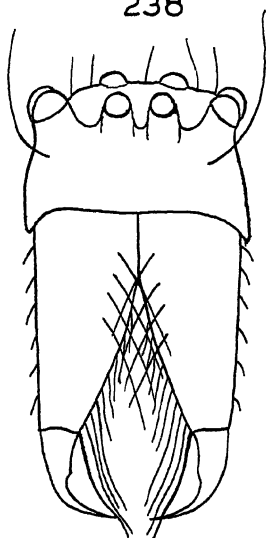
FIGURES 246 and 247. *Insecutor aculeatus* n. sp. Immature female.  
Paratype. British Museum, Coll. Klebs 480, No. 13447, In. 18723.

FIGURE 246. Palpal claw.

FIGURE 247. Eyegroup viewed from above.

FIGURE 248. *Insecutor mandibulatus* n. sp. Immature female. Paratype.  
British Museum, Coll. Klebs 478, No. 13434, In. 18721. Eyegroup viewed from above.

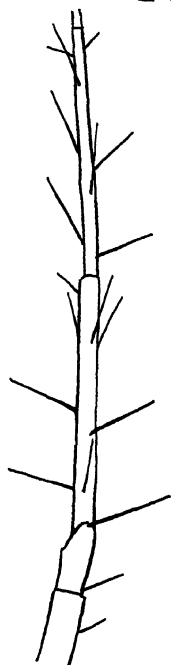
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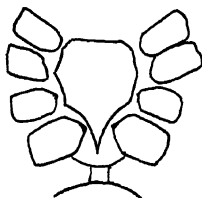
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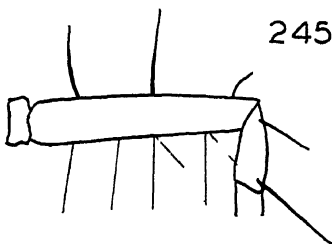
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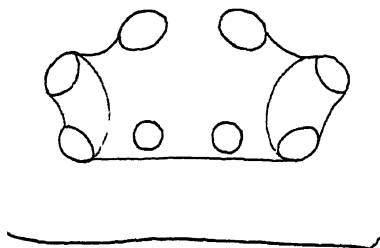
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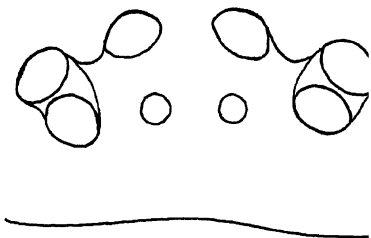
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## PLATE XXVII

FIGURES 249 and 250. *Insecutor mandibulatus* n. sp. Immature female. Paratype. British Museum, Coll. Klebs 478, No. 13434, In. 18721.

FIGURE 249. Lip and maxillae. Part of right maxilla not visible.

FIGURE 250. Spinnerets. The median pair not visible.

FIGURE 251. *Insecutor aculeatus* n. sp. Immature female. Paratype. British Museum, Coll. Klebs 480, No. 13447, In. 18723. Spinnerets and anal tubercle.

FIGURES 252 to 258. *Syphax crassipes* n. sp. Immature male. Type. British Museum, Coll. Klebs 479, No. 13449, In. 18722.

FIGURE 252. Carapace viewed from above showing head and entire eye-group.

FIGURE 253. Front view of face. In this position only the first row of eyes is visible.

FIGURE 254. Lip, maxillae, sternum and coxae. Notice that the anterior edge of the sternum has an emargination for the reception of the lip.

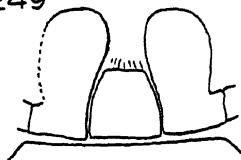
FIGURE 255. Prolateral view of first left metatarsus and tarsus showing relative proportions and spination.

FIGURE 256. End of second tarsus showing one of the claws and the claw-tufts.

FIGURE 257. Anterior spinnerets and colulus. The curved line in front is the edge of the first ventral abdominal fold.

FIGURE 258. Side view of spider with legs omitted to show the relative height of the carapace.

249



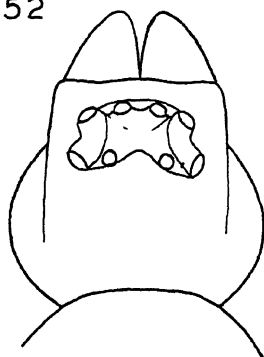
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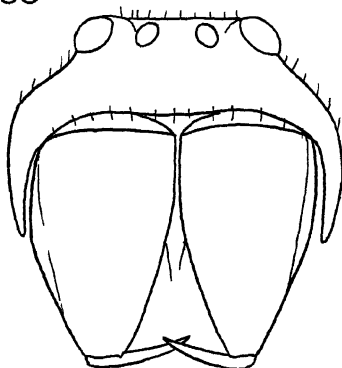
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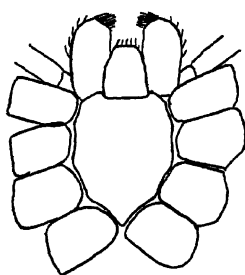
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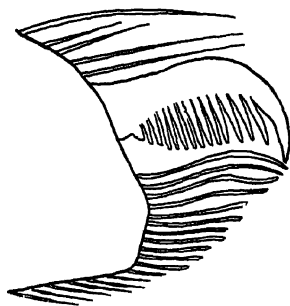
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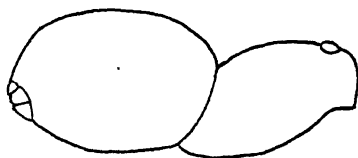
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## PLATE XXVIII

FIGURES 259 to 266. *Eomysmena moritura* n g, n. sp. Male. Type. British Museum, Coll. Samland, In. 18113.

FIGURE 259. Dorsal view of carapace and abdomen.

FIGURE 260. Lateral view of spider.

FIGURE 261. Eyegroup viewed from above.

FIGURE 262. Front view of face. Notice the high clypeus covered with rows of bristles, and the edge of the maxillae outside the chelicerae.

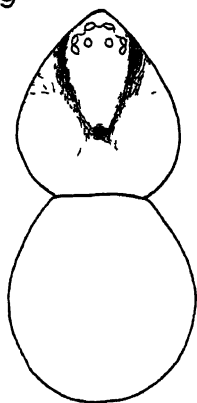
FIGURE 263. Sternum and coxae. The approximate shape of the lip and maxillae is indicated by a dotted line.

FIGURE 264. Retrolateral view of right palp. Notice the tibial apophysis.

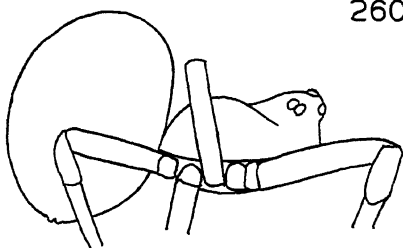
FIGURE 265. Entire right palp showing the relative proportions of the joints. The dotted line on the cymbium represents the area polished off by the previous owner.

FIGURE 266. Claws of second right tarsus.

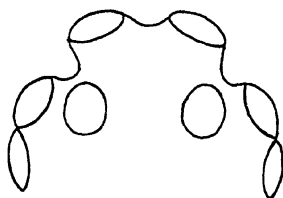
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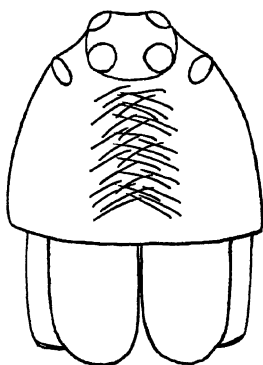
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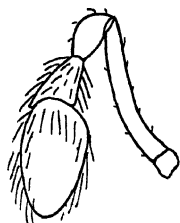
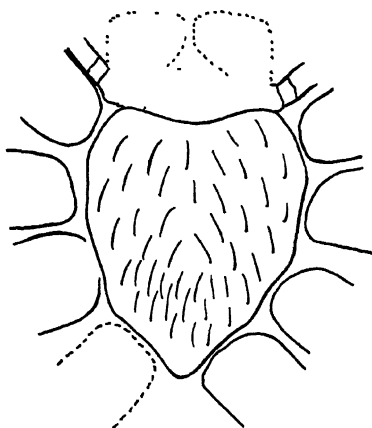
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## PLATE XXIX

FIGURES 267 to 272. *Adulatrix rufa* n. sp. Immature female. Type. British Museum, Coll. Klebs 488, No. 13440, In. 18731.

FIGURE 267. Dorsal view of carapace.

FIGURE 268. Front view of face.

FIGURE 269. Spinnerets. Notice the large size of the anterior pair.

FIGURE 270. Sternum, lip, maxillae and coxae.

FIGURE 271. Eyegroup viewed from above.

FIGURE 272. Claws of left fourth tarsus.

FIGURES 273 to 278. *Obnisus tenuipes* n. g., n. sp. Male. Type. British Museum, Coll. Samland, In. 18116.

FIGURE 273. Lateral view of carapace and abdomen.

FIGURE 274. Terminal joint of left palp. Notice the pickaxe-shaped apophysis. Prolateral view.

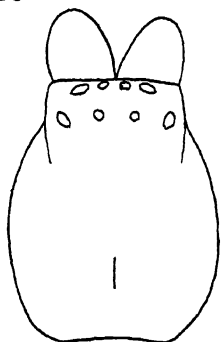
FIGURE 275. Claws of second right tarsus. Notice the slight dissimilarity of the upper claws.

FIGURE 276. Second right patella and tibia showing general proportions and arrangement of spines.

FIGURE 277. Spinnerets viewed from the right side.

FIGURE 278. Spinnerets, colulus and anal tubercle. Notice the small median spinnerets.

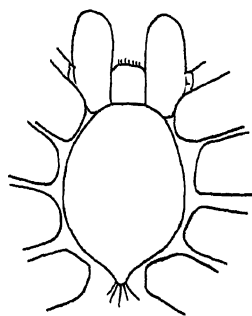
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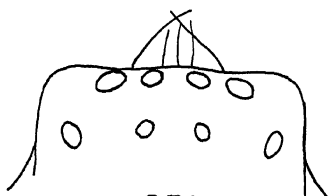
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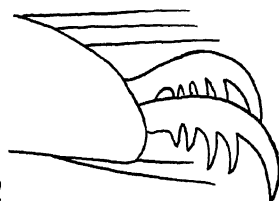
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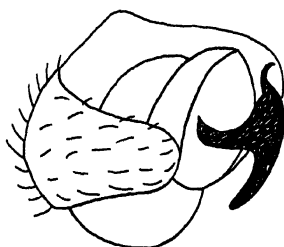
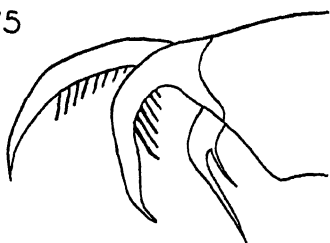


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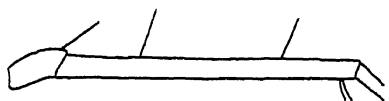
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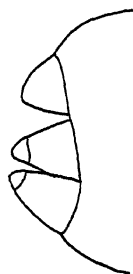
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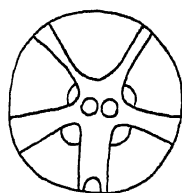
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## PLATE XXX

FIGURES 279 to 288. *Eustaloides setosus* n. g., n. sp. Male. Type. British Museum, Coll. Samland, In. 18117.

FIGURE 279. Dorsal view of carapace.

FIGURE 280. Lateral view of carapace and abdomen.

FIGURE 281. Eyegroup viewed from above.

FIGURE 282. Left palp, dorsal aspect. The dotted line represents the area polished off by the previous owner.

FIGURE 283. End of third right tarsus showing the upper retroclaw, the third claw, one spurious claw and a forked bristle.

FIGURE 284. Second left proclaw.

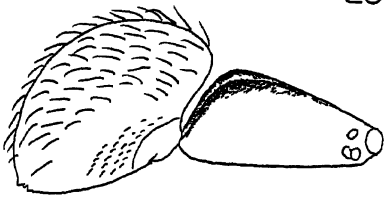
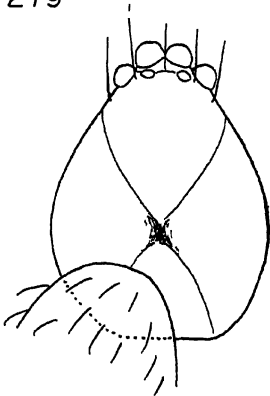
FIGURE 285. Front view of face.

FIGURE 286. Sternum, coxae and probable outline of lip and maxillae.

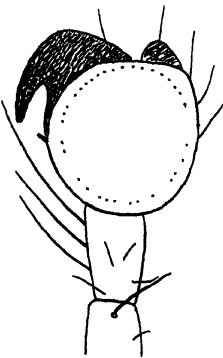
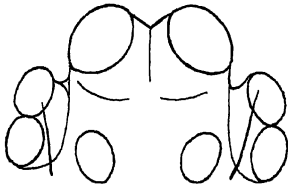
FIGURE 287. Spinnerets, colulus and anal tubercle.

FIGURE 288. Fourth right leg showing general proportions and spines.

FIGURE 289. *Eogonatium succini* n. g., n. sp. Female. Type. British Museum, Coll. Samland, In. 18943. Epigynum.



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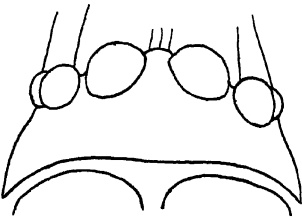
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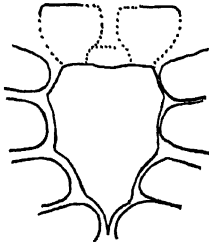
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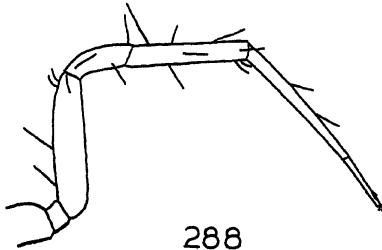
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## PLATE XXXI

FIGURES 290 to 299. *Adjutor mirabilis* n. g., n. sp. Immature female. Type. British Museum, Coll. Samland, In. 18945.

FIGURE 290. Dorsal view of carapace. Notice the circular bases of the bristles.

FIGURE 291. Sternum, lip, maxillae, chelicerae and coxae. The visible outline of the sternum may not be its actual outline and represents the area made conspicuous by an underlying layer of air.

FIGURE 292. Front view of face.

FIGURE 293. End of first right tarsus showing the retroclaw and the third claw.

FIGURE 294. Dorsal view of abdomen.

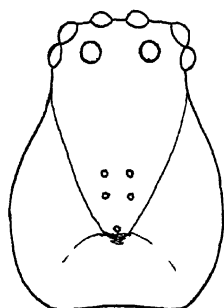
FIGURE 295. Lateral view of carapace with the five dorsal bristles.

FIGURE 296. Spinnerets and colulus viewed from below. Notice the difference in size between the anterior and posterior pair. Notice also the large spigots on the anterior spinnerets and the common spinning tubes on the median and posterior pair.

FIGURE 297. Palpal claw.

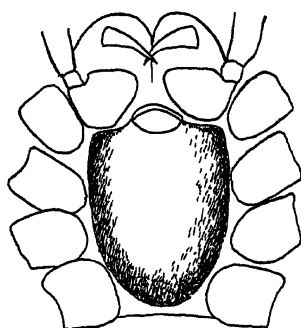
FIGURE 298. Fourth right leg showing general proportions, hair, spines and trichobothria. Notice the extraordinary length of the latter.

FIGURE 299. Left palp to show general proportions.

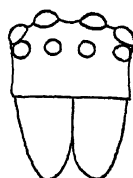


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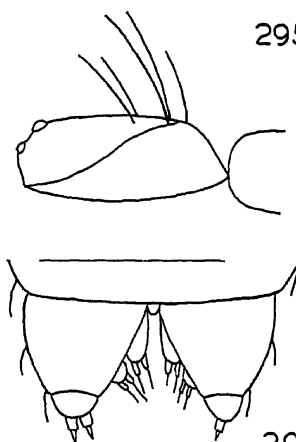
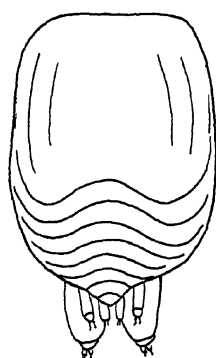
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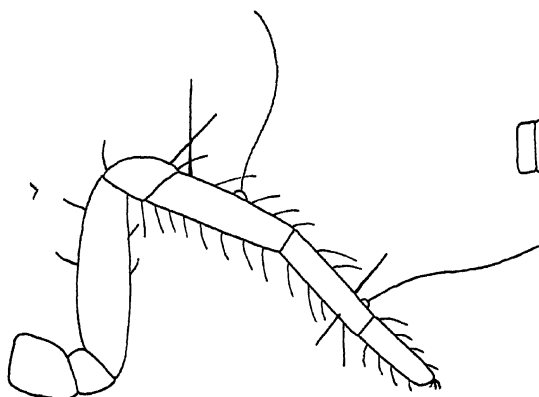


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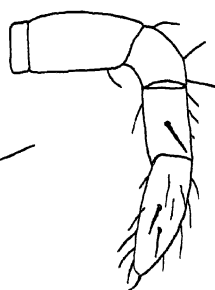
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## PLATE XXXII

FIGURES 300 to 307. **Miropholcus heteropus** n. g., n. sp. Immature male. Type. British Museum, Coll. Samland, In. 18139-C.

FIGURE 300. Dorsal view of spider. Legs of right side omitted. Notice the extraordinary size of the fourth leg.

FIGURE 301. Carapace in three-quarter view showing eyes, clypeus and right bristle.

FIGURE 302. End of first left tarsus showing the small claws.

FIGURE 303. Left palp showing the swollen condition of the terminal joint. Notice the slit organs (lyriform organs) on the patella.

FIGURE 304. The slit organs under very high power. (4 mm. objective, X30 ocular.)

FIGURE 305. Anal tubercle and spinnerets viewed from the left side.

FIGURE 306. Carapace viewed from above showing the eyegroup and the two bristles.

FIGURE 307. An anterior spinneret under high power.

FIGURES 308 to 311. **Myro hirsutus** n. sp. Male. Type. British Museum, Coll. Samland, In. 18907.

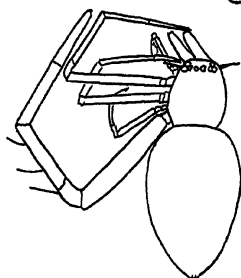
FIGURE 308. Sternum and coxae.

FIGURE 309. Retroclaw and third claw of fourth tarsus.

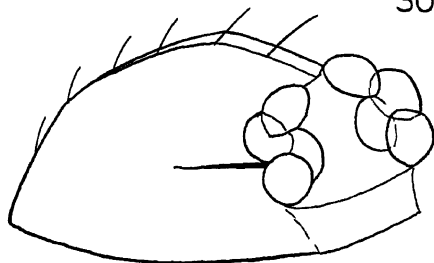
FIGURE 310. Proclaw and third claw of second tarsus.

FIGURE 311. Left palp in retrolateral view.

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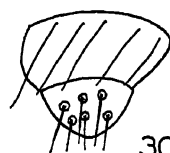
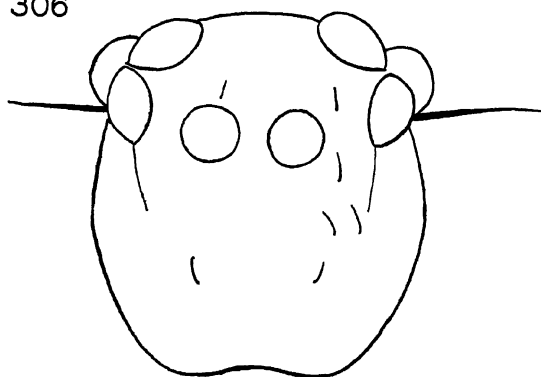
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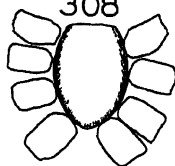


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### PLATE XXXIII

FIGURES 312 to 322. *Admissor aculeatus* n. g., n. sp. Female. Type. British Museum, Coll. Samland, In. 18946.

FIGURE 312. Chelicerae, maxillae, lip, sternum and coxae.

FIGURE 313. End of posterior spinneret with five spinning tubes.

FIGURE 314. Anal tubercle and spinnerets in three-quarter view.

FIGURE 315. Anal tubercle, colulus and the spinnerets.

FIGURE 316. Palpal claw.

FIGURE 317. Retrolateral view of left chelicera showing the two retromarginal teeth.

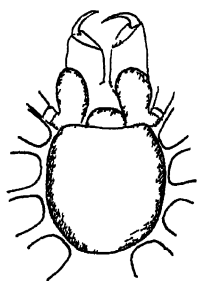
FIGURE 318. Anterior spinneret with four spigots. Only the end of the spinneret is shown.

FIGURE 319. Right palp with maxilla.

FIGURE 320. Third right leg showing proportions and spines.

FIGURE 321. First right proclaw and third claw.

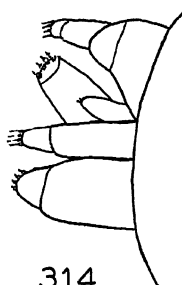
FIGURE 322. Lateral view of spider. In this position the carapace is foreshortened, the coxae of the third and fourth right legs are not visible behind the femur of the second leg.



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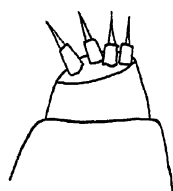
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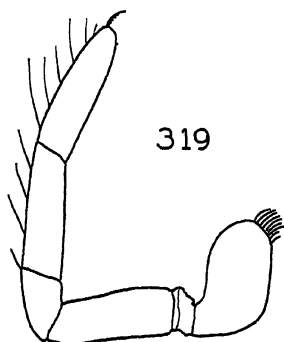
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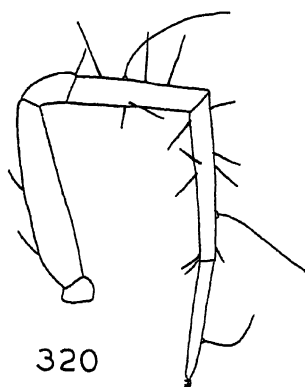
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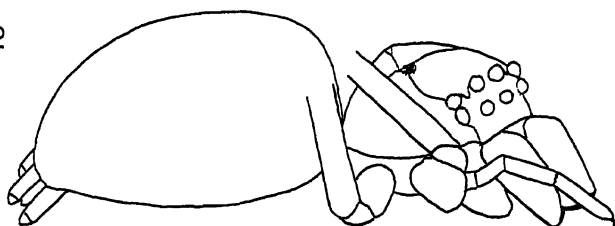


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## PLATE XXXIV

FIGURES 323 to 328. *Adjunctor similis* n. g., n. sp. Female. Type. British Museum, Coll. Samland, In. 18085.

FIGURE 323. View of spider from above. Abdomen represented in the position in which it would be normally. In the specimen it is twisted out of position.

FIGURE 324. Sternum and coxae.

FIGURE 325. Anal tubercle and spinnerets viewed from the left side.

FIGURE 326. Lateral view of spider.

FIGURE 327. Claws of second right tarsus.

FIGURE 328. Second leg showing proportions, spines and trichobothria.

FIGURES 329 to 332. *Liticen setosus* n. g., n. sp. Male. Type. British Museum, Coll. Samland, In. 18118.

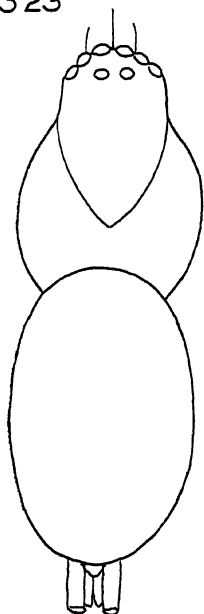
FIGURE 329. Retrolateral view of right palp.

FIGURE 330. Claws of fourth tarsus.

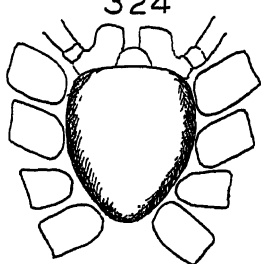
FIGURE 331. Maxillae, lip, sternum and coxae.

FIGURE 332. Carapace viewed from above showing complete eyegroup.

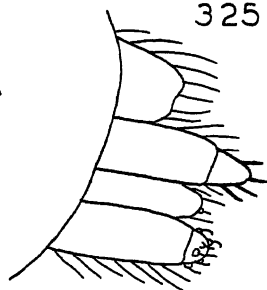
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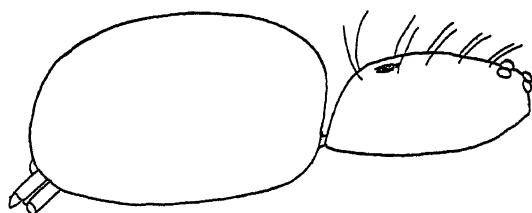
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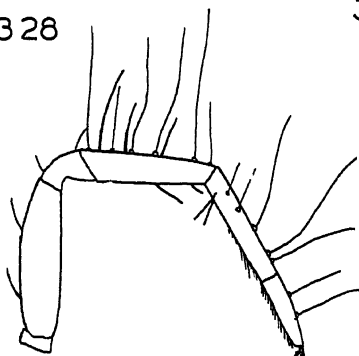
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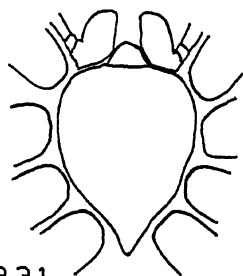
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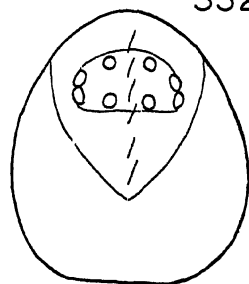
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## PLATE XXXV

FIGURES 333 to 337. *Eogonatum succini* n. sp. Female. Type. British Museum, Coll. Samland, In. 18943.

FIGURE 333. Fourth left metatarsus showing the erect, short spines and the hair.

FIGURE 334. Side view of spider. Only first femur is shown so as not to obstruct the view.

FIGURE 335. Fourth leg showing proportions and spines.

FIGURE 336. Eyegroup viewed from above.

FIGURE 337. Front view of face.

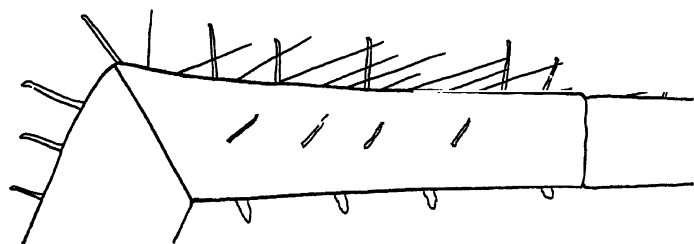
FIGURES 338 to 340. *Theridiometa samlandica* n. sp. Exuvium. British Museum, Seeböhm's bequest, In. 17629.

FIGURE 338. Carapace viewed from above.

FIGURE 339. Eyegroup viewed from above.

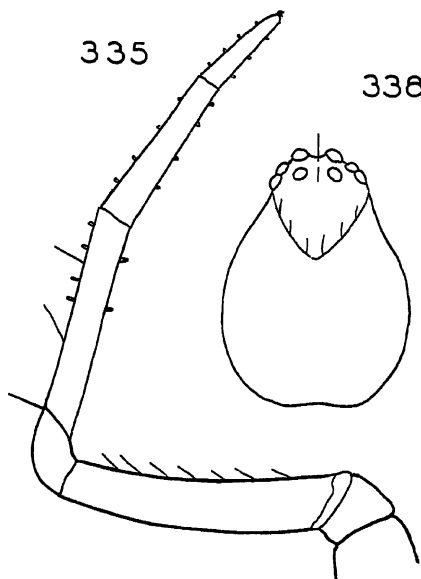
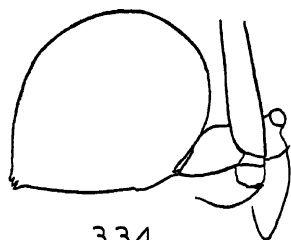
FIGURE 340. First left metatarsus showing short, erect spines and hair.

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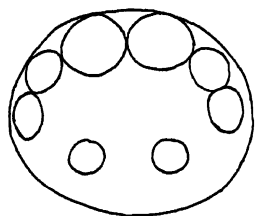
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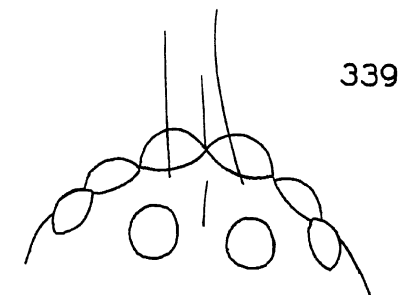


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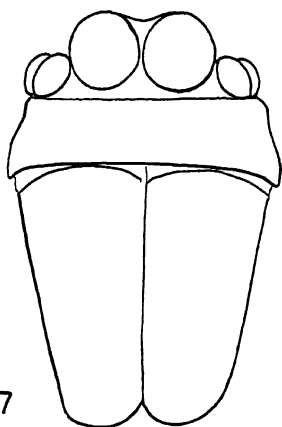
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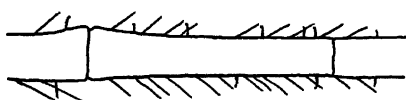
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## PLATE XXXVI

FIGURES 341 to 346. *Eomysmena succini* n. g., n. sp. Male. Type British Museum, Coll. Samland, In. 18114.

FIGURE 341. Dorsal view of carapace and abdomen. The femora are also shown complete.

FIGURE 342. Fourth left metatarsus and tarsus showing the tarsal comb.

FIGURE 343. Eyegroup viewed from above.

FIGURE 344. Eyegroup and clypeus viewed from in front.

FIGURE 345. Claws of fourth left tarsus. This figure is a composite one of two figures drawn in different positions of the leg.

FIGURE 346. Second left leg showing proportions.

FIGURES 347 to 350. *Mystagogus glaber* n. g., n. sp. Male. Type. British Museum, Coll. Samland, In. 18125.

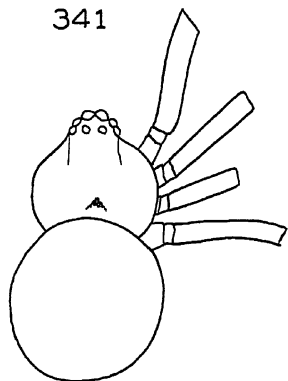
FIGURE 347. Dorsal view of spider. The legs which are turned under are not shown.

FIGURE 348. Anal tubercle and spinnerets shown in a three-quarter side view.

FIGURE 349. Right palp viewed from below. Notice the tibial apophysis.

FIGURE 350. Maxillae, lip, sternum and coxae.

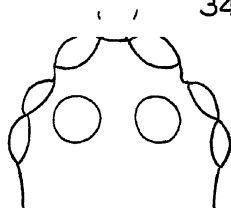
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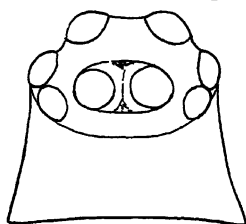
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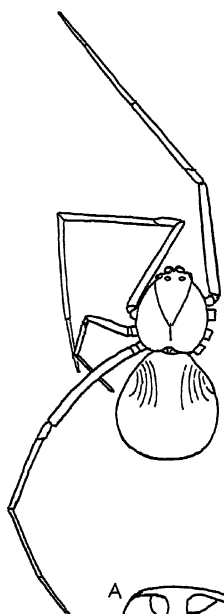
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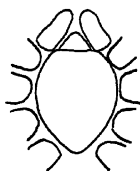
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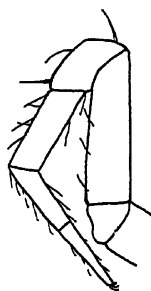
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## PLATE XXXVII

FIGURES 351 to 353. *Theridiometa samlandica* n. sp. Immature female. British Museum, Coll. Samland, In. 18132.

FIGURE 351. Eyegroup viewed from above.

FIGURE 352. Face viewed from in front. The lines to the outside of the chelicerae are the maxillae.

FIGURE 353. Prolateral view of first left leg showing proportions and spines.

FIGURES 354 to 359. *Meditrina circumvallata* n. g., n. sp. Female. Type. British Museum, Coll. Samland, In. 18159.

FIGURE 354. View of face from in front, but greatly foreshortened.

FIGURE 355. Diagrammatic transverse section through the carapace to explain the thickening of its margins.

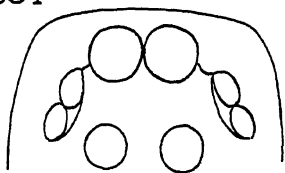
FIGURE 356. Carapace viewed from above. In this position the right posterior portion is covered by the abdomen represented by the curved line in its natural position.

FIGURE 357. Retrolateral upper claw and third claw of the first left tarsus.

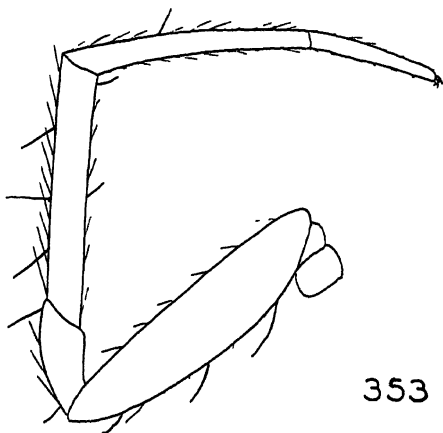
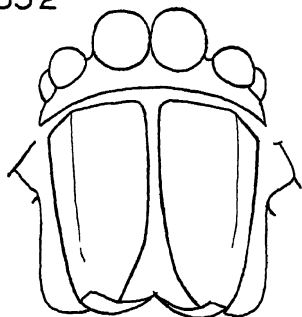
FIGURE 358. Palpal claw.

FIGURE 359. Entire body of spider viewed from the left side. The legs are omitted. Notice the size of the abdomen; also the genital fold with the opening of the left lung.

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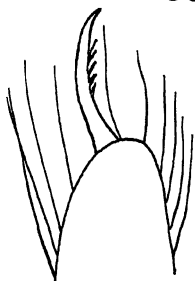
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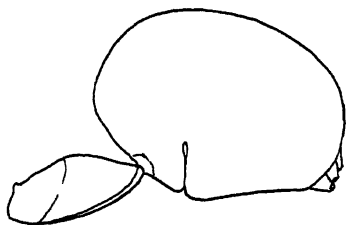
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## PLATE XXXVIII

FIGURES 360 to 367. *Myro fossilis* n. sp. Female. Type. British Museum, Coll. Samland, In. 18115.

FIGURE 360. Maxillae, sternum and coxae. The lip cannot be seen.

FIGURE 361. Eyegroup viewed from above.

FIGURE 362. Eyegroup viewed from in front. The curved line above the eyes represents the outline of the carapace.

FIGURE 363. Spinnerets viewed from below. The curved line represents the end of the abdomen.

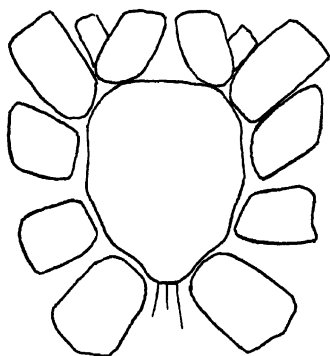
FIGURE 364. End of abdomen and spinnerets viewed from the left side.

FIGURE 365. Dorsal view of carapace.

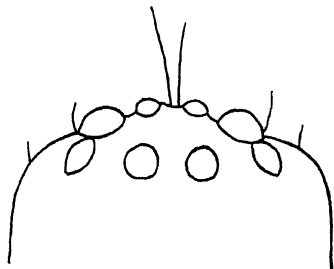
FIGURE 366. Retrolateral view of fourth left leg, showing proportions and spines on tibia and metatarsus.

FIGURE 367. Face viewed from in front.

360



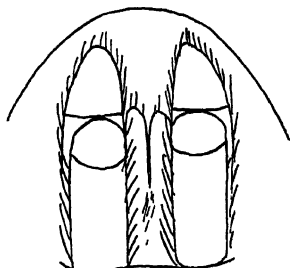
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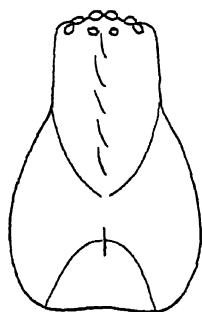
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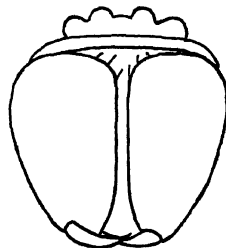
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## PLATE XXXIX

FIGURES 368 to 371. *Eostasina aculeata* n. g., n. sp. Female. Type. British Museum, Coll. Samland, In. 18111.

FIGURE 368. View of the spider from below with only two legs shown. The oval area at the end of the abdomen represents the portion polished off by the previous owner.

FIGURE 369. Palpal claw.

FIGURE 370. Tarsal claws of fourth leg.

FIGURE 371. Ventral view of first metatarsus and tarsus showing the unusually long ventral metatarsal spines.

FIGURES 372 to 378. *Insecutor rufus* n. sp. Female. Type. British Museum, Coll. Samland, In. 18123.

FIGURE 372. Lateral view of the spider.

FIGURE 373. Dorsal view of carapace.

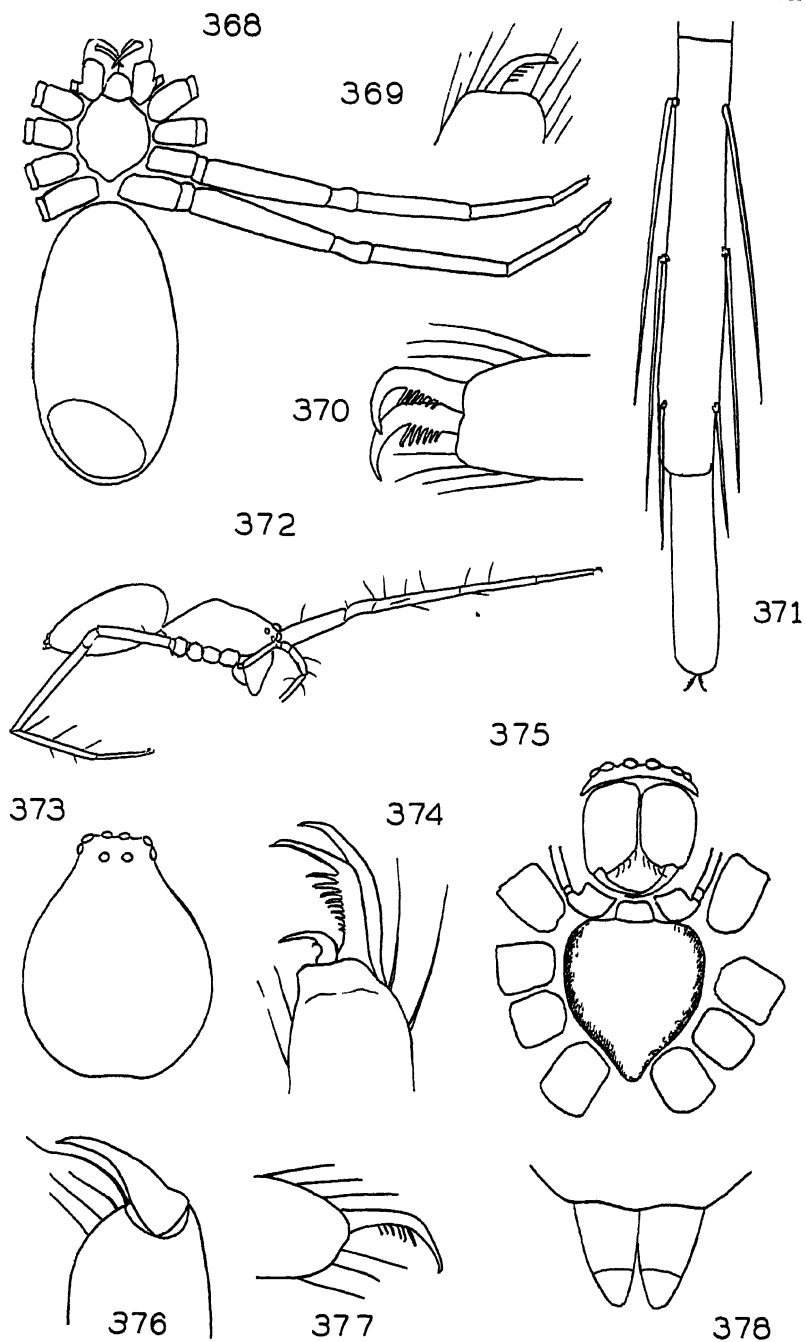
FIGURE 374. Tarsal claws.

FIGURE 375. Face, maxillae, lip, sternum and coxae.

FIGURE 376. End of right chelicera viewed from below.

FIGURE 377. Palpal claw.

FIGURE 378. Anterior spinnerets. The other spinnerets are not visible in this position.



## PLATE XL

FIGURE 379. *Misumena samlandensis* n. sp. Female. Type. British Museum, Coll. Samland, In. 18120. Dorsal view of spider.

FIGURES 380 to 385. *Filiola argentata* n. g., n. sp. Female. Type. British Museum, Coll. Samland, In. 18139-B.

FIGURE 380. Front view of face.

FIGURE 381. Anal tubercle, colulus and spinnerets viewed from below.

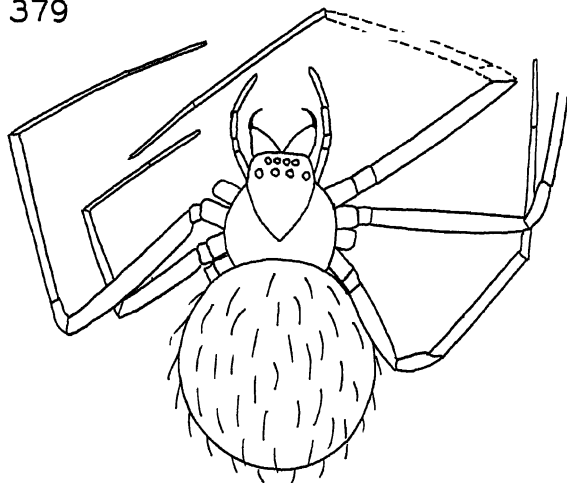
FIGURE 382. Eyegroup viewed from above.

FIGURE 383. Dorsal view of spider. Only one leg is shown.

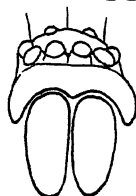
FIGURE 384. Side view of head showing eyes, clypeus and right chelicera.

FIGURE 385. Sternum and coxae. The mouthparts are not visible, their view being obstructed by the legs.

379



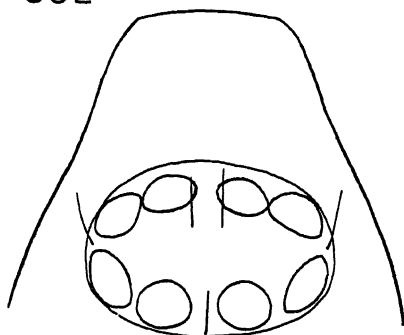
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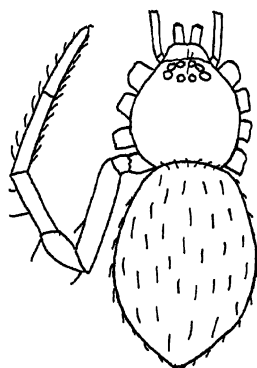
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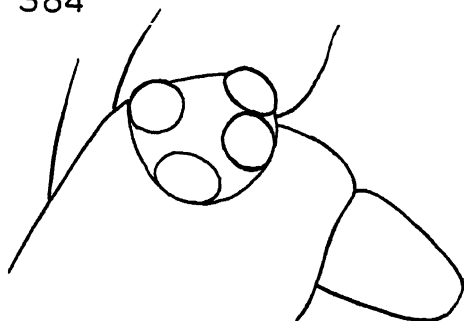
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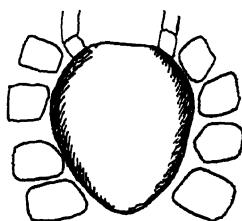
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## PLATE XLI

FIGURES 386 to 391. *Medela baltica* n. g., n. sp. Female. Type. British Museum, Coll. Samland, In. 18139-A.

FIGURE 386. Dorsal view of spider. Legs not shown.

FIGURE 387. Front view of face.

FIGURE 388. Eyegroup viewed from above.

FIGURE 389. Sternum and coxae. The mouthparts are obstructed from view by heavy emulsion.

FIGURE 390. Prolateral view of first left leg showing proportions.

FIGURE 391. Dorsal view of fourth right patella. Notice the strong projection in the middle of the retrolateral edge.

FIGURES 392 to 397. *Adulatrix parva* n. sp. Female. Type. British Museum, Coll. Samland, In. 18124.

FIGURE 392. Dorsal view of spider with legs omitted.

FIGURE 393. One of the tarsal claws of the first foot.

FIGURE 394. Prolateral view of first right leg showing proportions and trichobothria.

FIGURE 395. Dorsal view of eyegroup.

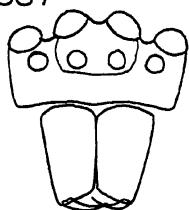
FIGURE 396. One of the spatulate hairs of the tarsal scopula magnified  $\times 1100$ . The inner line shows the central cavity.

FIGURE 397. Portion of the ventral surface of the first tarsus showing three spinelike hairs and the spatulate hairs of the scopula.

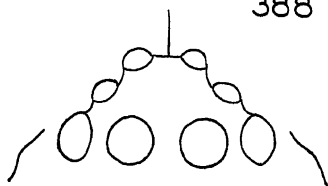
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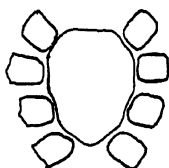
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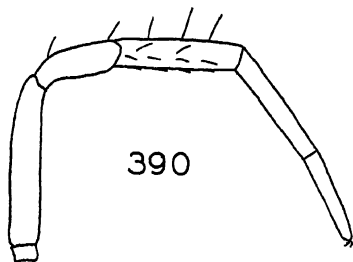
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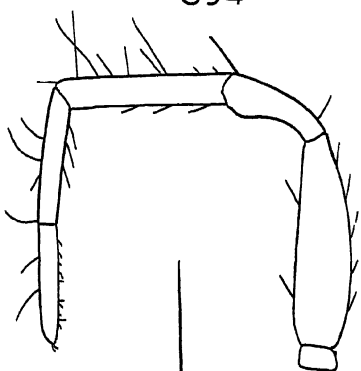
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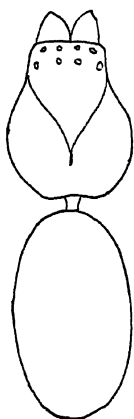
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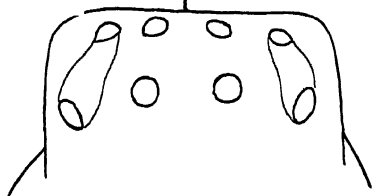


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## PLATE XLII

FIGURES 398 to 406. *Amaurobius succini* n. sp. Exuvium of male.  
Type. British Museum, Samland, In. 18160.

FIGURE 398. Carapace as viewed from inside.

FIGURE 399. Sternum, lip and maxillae.

FIGURE 400. Cymbium of a palp, showing that it is an immature male.

FIGURE 401. Right chelicera viewed from below. Notice the promarginal scopula with a single series of nine bristles.

FIGURE 402. End of carapace and eyegroup.

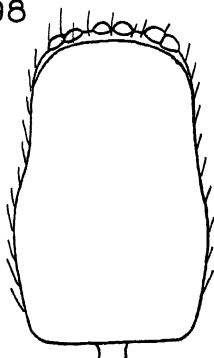
FIGURE 403. End of first tarsus showing one of the upper claws and the third claw.

FIGURE 404. Two of the threads of silk surrounding the exuvium. These threads are of the cribellar type. They have been drawn at a magnification of  $\times 2250$  and reduced in printing to 1125.

FIGURE 405. Outside view of left chelicera showing the boss.

FIGURE 406. First left leg in prolateral view, showing general proportions, spines and oblique rows of small trichobothria.

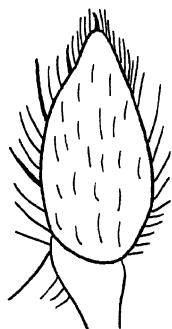
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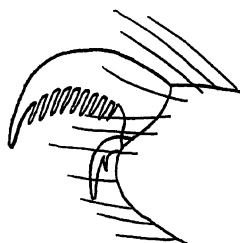
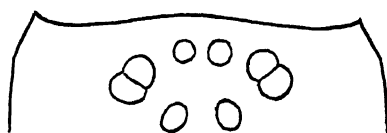
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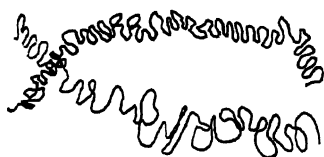
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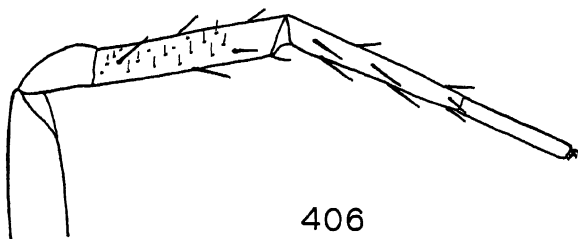
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PLATE XLIII

FIGURES 407 to 414. *Arthrodictyna segmentata* n. g., n. sp. Pullus.  
Type. British Museum, Samland, In. 18950.

FIGURE 407. View of entire spider from below.

FIGURE 408. Ends of chelicerae showing fangs and scopulae.

FIGURE 409. Abdomen viewed from below. Notice the ventral sclerites,  
the spinning group and the lateral plications. Notice also that the  
spinning group occupies almost half of the abdomen.

FIGURE 410. Left palp viewed from below.

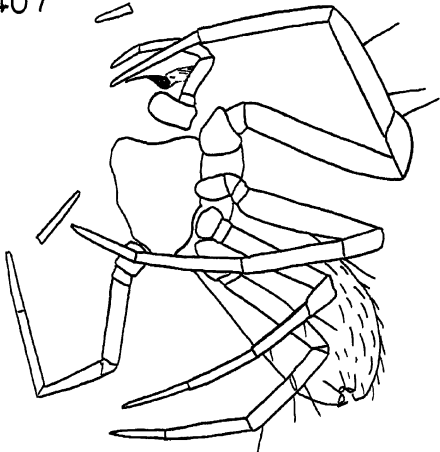
FIGURE 411. Claws of left third tarsus. Notice the two stout bristles.

FIGURE 412. Cribellum, spinnerets and anal tubercle.

FIGURE 413. A hair from a spinneret.

FIGURE 414. Fourth leg showing the calamistrum.

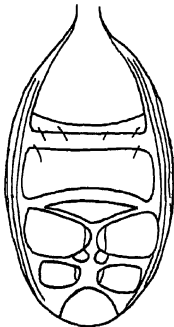
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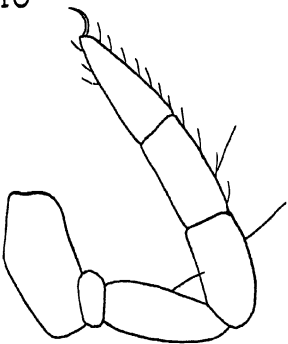
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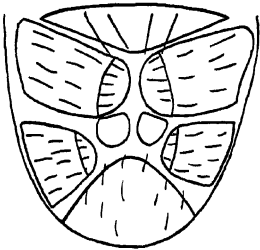


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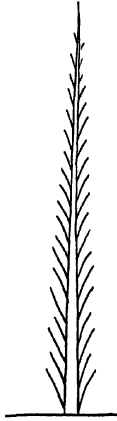


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## PLATE XLIV

FIGURES 415 to 421. *Facundia clara* n. g., n. sp. Immature female.  
Type. British Museum, Samland, In. 18127.

FIGURE 415. Front view of spider.

FIGURE 416. Retrolateral view of first right leg showing general proportions, spines and trichobothria.

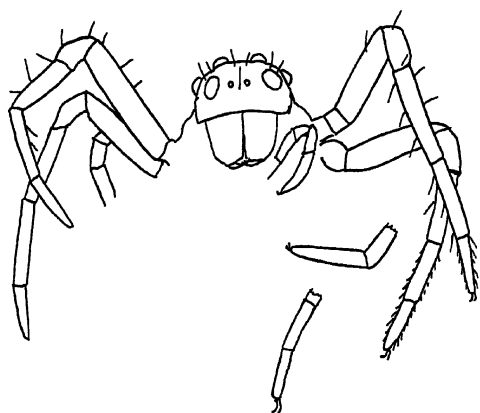
FIGURE 417. Front view of face.

FIGURE 418. Sternum, lip, left maxilla and coxae, all that is visible in the specimen. The interrupted line shows the edge of the sternum where it was polished off by the previous owner. The dotted line shows the probable outline of the sternum.

FIGURE 419. Eyegroup viewed from above.

FIGURE 420. Claws of first left tarsus in retrolateral view.

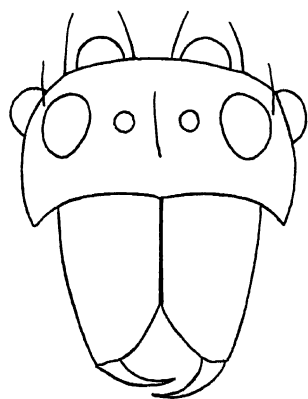
FIGURE 421. A serrated bristle from the head, magnified ca.  $\times 1125$ .



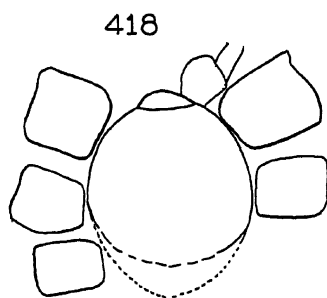
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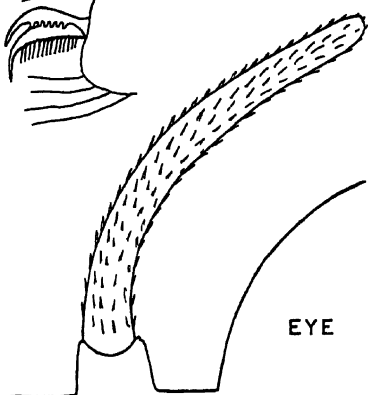
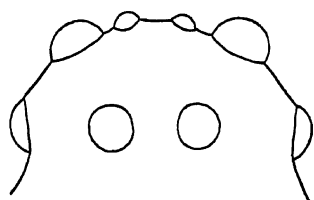
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EYE



## PLATE XLV

FIGURES 422 to 426. *Impulsor neglectus* n. g., n. sp. Male. Type. British Museum, Samland, In. 18122.

FIGURE 422. Sternum, lip, maxillae and coxae.

FIGURE 423. Right palp viewed from above. Notice the needle-like end of the embolus and the tibial apophysis.

FIGURE 424. Dorsal view of left palp. The cymbium was polished off by the original owner exposing the entire embolus.

FIGURE 425. End of a tarsus showing the proclaw, the third claw and two spurious claws.

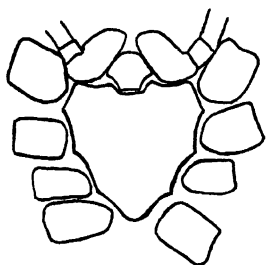
FIGURE 426. The retroclaw of the same tarsus as in figure 425.

FIGURES 427 and 428. *Liticen setosus* n. g., n. sp. Male. Type. British Museum, Samland, In. 18118.

FIGURE 427. Lateral view of spider. Only anterior right leg shown, so as not to obstruct the view of the body.

FIGURE 428. Tibia and patella of first right leg showing the relative length of the bristles and setose hair.

422



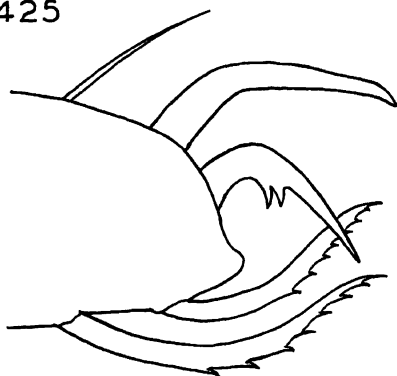
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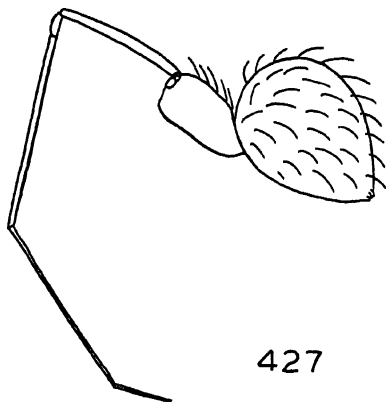
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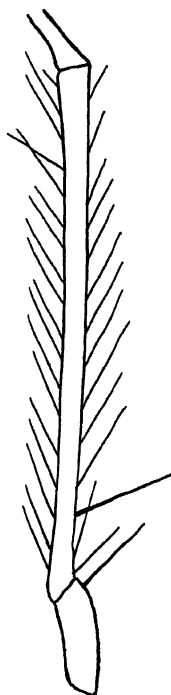
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## PLATE XLVI

FIGURES 429 to 433 *Eomatachia latifrons* n. g., n. sp. Male. British Museum, Seeböhm's bequest. In. 17612.

FIGURE 429. Spinnerets in strong, transmitted light. The base of the anterior spinnerets shown by a dotted line is visible through the cribellum.

FIGURE 430. Lateral view of the spinnerets and anal tubercle.

FIGURE 431. Eyegroup viewed from in front in transmitted light.

FIGURE 432. Patella and tibia of the right palp showing the tibial apophyses. Only the base of the cymbium is shown.

FIGURE 433. Prolateral view of right chelicera in strong transmitted light. Notice the poison duct, the prolateral scopula and the three retrolateral teeth.

FIGURES 434 and 435. Male. Paratype. British Museum, Coll. Klebs 490, No. 13396, In. 18733.

FIGURE 434. Retrolateral view of left palp showing general proportions.

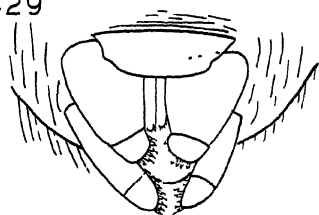
FIGURE 435. Prolateral view of fourth left metatarsus showing spines and calamistrum.

FIGURES 436 and 437. Male. Type. British Museum, Coll. Klebs 494, No. 13433, In. 18737.

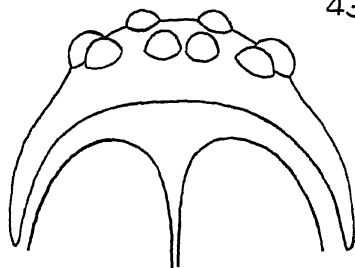
FIGURE 436. A group of simple and plumose hairs from the sternum

FIGURE 437. Claws of second right tarsus. Only proclaw and third claw are shown.

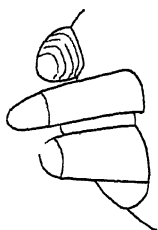
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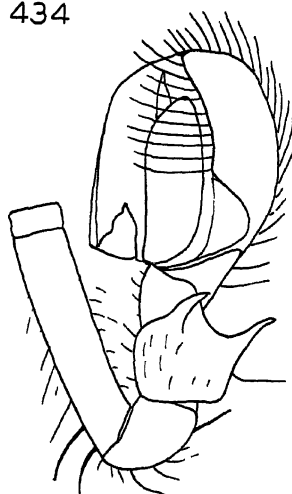
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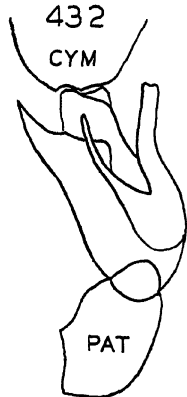


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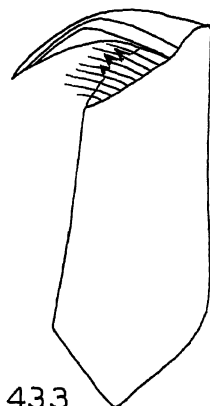


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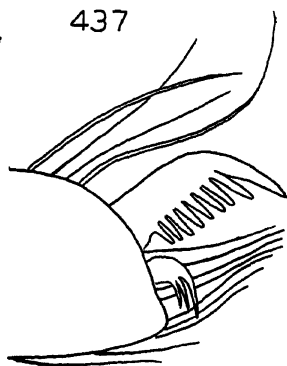


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## PLATE XLVII

FIGURE 438. *Eomatachia latifrons* n. g., n. sp. Male. British Museum, Seebohm's bequest, In. 17612. Dorsal view of spider.

FIGURES 439 to 441. *Theridium simplex* (Koch and Berendt). Female. British Museum, Samland, In. 18135.

FIGURE 439. Dorsal view of spider. A composite drawing in which the cephalothorax and appendages were first drawn, then the specimen was tilted to bring the abdomen in the right position.

FIGURE 440. Side view of abdomen showing the petiolus, genital opening, lung with the lung slit and spinnerets.

FIGURE 441. Fourth right tarsus showing the tarsal comb and claws. Notice that the dorsal bristles are almost as long as those forming the comb.

FIGURES 442 to 445. *Theridiometa edwardsi* n. sp. Pullus. British Museum, Samland, In. 18121.

FIGURE 442. Dorsal view of spider.

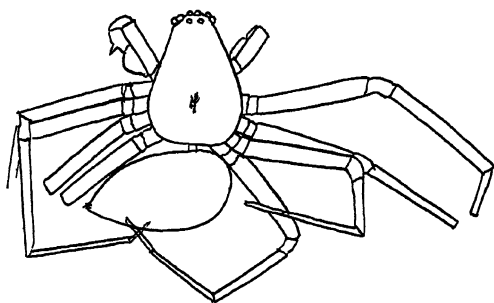
FIGURE 443. Dorsal view of eyegroup.

FIGURE 444. Right chelicera showing the three promarginal teeth.

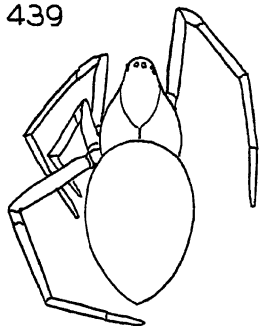
FIGURE 445. Palpal claw.

FIGURE 446. *Mystagogus glaber* n. g., n. sp. Male. Type. British Museum, Samland, In. 18125. Eyegroup viewed from above.

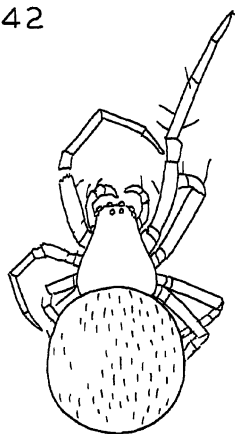
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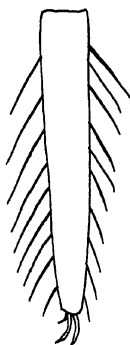
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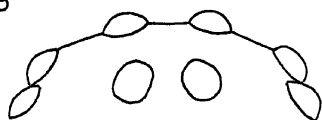
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## PLATE XLVIII

FIGURES 447 to 455. *Paralinius crosbyi* n. g., n. sp. Male. Type. Cornell University, No. 1.

FIGURE 447. Dorsal view of carapace.

FIGURE 448. Side view of carapace.

FIGURE 449. Front view of face.

FIGURE 450. Dorsal view of abdomen. Notice lines of segmentation.

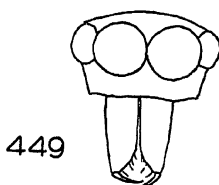
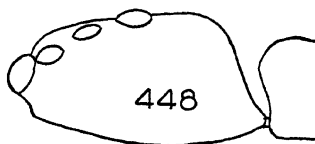
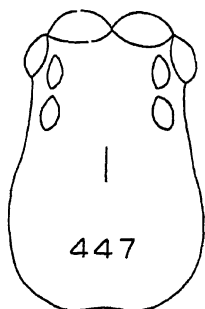
FIGURE 451. Left palp viewed from in front. Notice the long tibial apophysis extending over the tibia in the shape of a crest, then continuing as a strong thorn or needle.

FIGURE 452. Right palp viewed from below. Notice that the embolus arises from the end of the bulb.

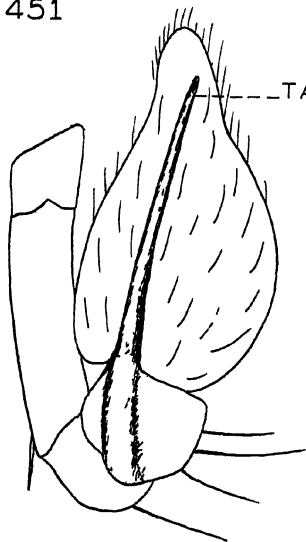
FIGURE 453. Retroclaw and claw-tufts of fourth left tarsus. The proclaw is not shown. It is similar to the retroclaw, but has only five teeth.

FIGURE 454. Side view of spinnerets and anal tubercle.

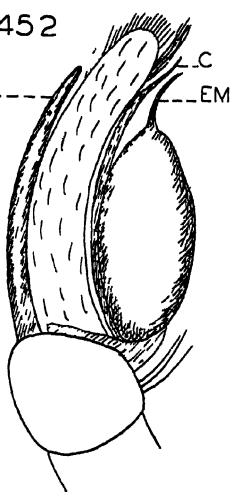
FIGURE 455. Lip, sternum, maxillae and coxae.



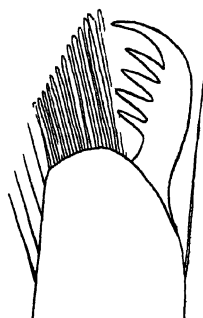
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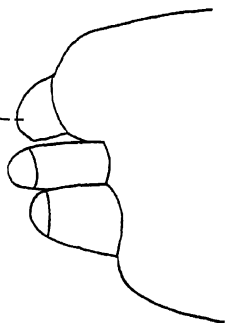
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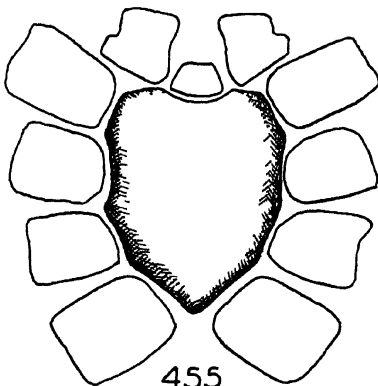
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## PLATE XLIX

FIGURES 456 to 460. *Eolinus theryi* n. sp. Male. Peabody Museum, Yale University.

FIGURE 456. Eyegroup viewed from above.

FIGURE 457. Palp, ventral view. EM—embolus, X—sclerite at base of bulb, VA—ventral tibial apophysis.

FIGURE 458. End of first tarsus showing claws and claw-tufts. Prolateral view.

FIGURE 459. Right chelicera showing four teeth on the retrolateral margin.

FIGURE 460. Palp. Dorsal view.

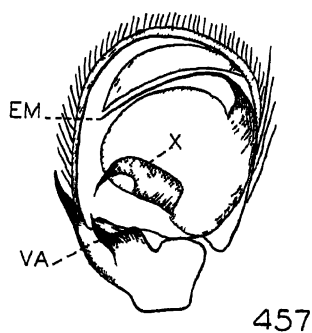
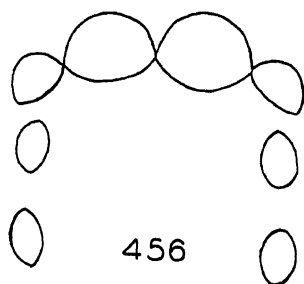
FIGURES 461 to 464. *Eodipoena bassleri* n. sp. Female. Type U. S. Nat. Mus.

FIGURE 461. Ventral view showing mouthparts, sternum and coxae.

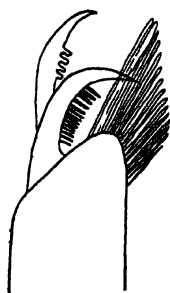
FIGURE 462. Three-quarter view of spinnerets. COL—colulus, AT—anal tubercle.

FIGURE 463. Epigynum.

FIGURE 464. Dorsal view of first left metatarsus and tarsus, showing proportions and the short erect hairs.



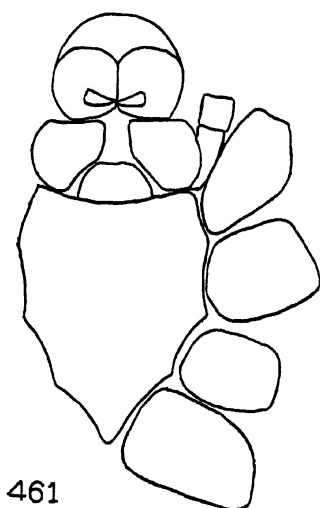
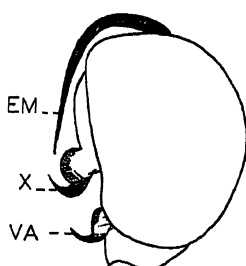
458



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462



## PLATE L

FIGURES 465 to 469. *Paruroctea blauvelti* n. g., n. sp. Female. Type. Cornell University, No. 2.

FIGURE 465. Dorsal view of carapace.

FIGURE 466. Maxillae, lip, sternum and coxae.

FIGURE 467. Retrolateral view of the end of the third left tarsus, showing the claws.

FIGURE 468. Palpal claw.

FIGURE 469. Spinnerets. Notice the fringe of long hairs on the anal tubercle. TR—tracheal spiracle.

FIGURES 470 to 474. *Steatoda succini* n. sp. Female. Type. Cornell University. No. 3.

FIGURE 470. Ventral view of maxillae, lip, sternum and coxae.

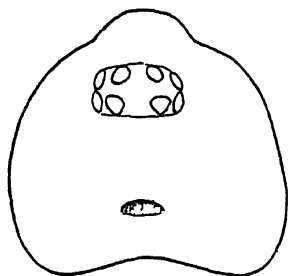
FIGURE 471. Fourth leg showing general proportions and spines.

FIGURE 472. One of the similar upper claws and the third claw of the fourth tarsus.

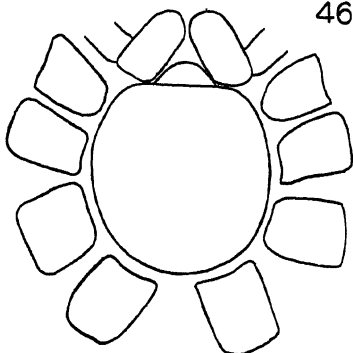
FIGURE 473. First metatarsus and tarsus showing general proportions.

FIGURE 474. Epigynum. The dark receptacles are visible through the chitinous disc.

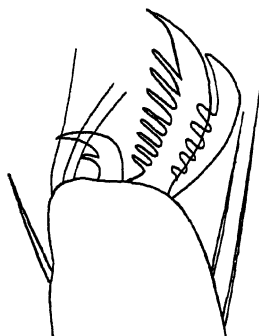
465



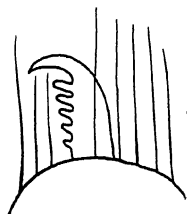
466



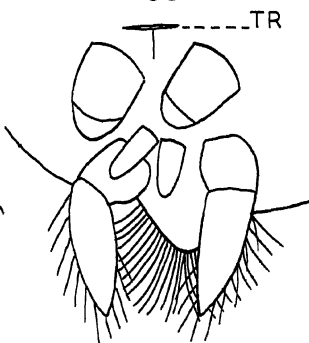
467



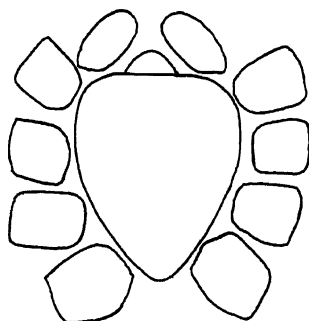
468



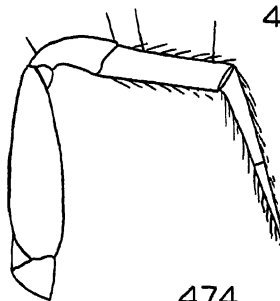
469



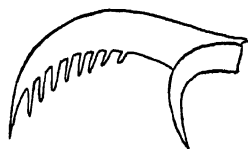
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## PLATE LI

FIGURES 475 to 483. *Nactodipoena dunbari* n. g., n sp. Male. Type. Peabody Museum, Yale University, No. 2.

FIGURE 475. Dorsal view of carapace. The curved lines represent the area of the depression.

FIGURE 476. Lateral view of carapace.

FIGURE 477. Front view of face.

FIGURE 478. Ventral view of lip, maxillae, sternum and coxae.

FIGURE 479. Proclaw and third claw of fourth tarsus

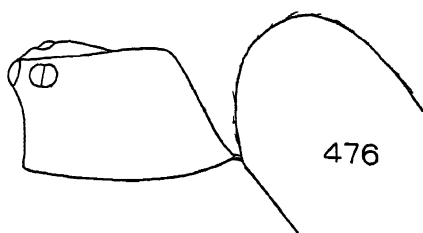
FIGURE 480. First leg showing general proportions and spines.

FIGURE 481. Retrolateral view of right palp.

FIGURE 482. Left fourth metatarsus and tarsus showing the tarsal comb

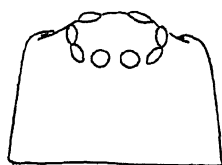
FIGURE 483. Dorsal view of eyegroup.

475

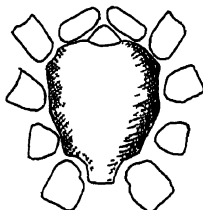


476

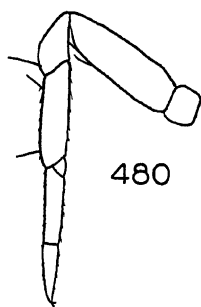
477



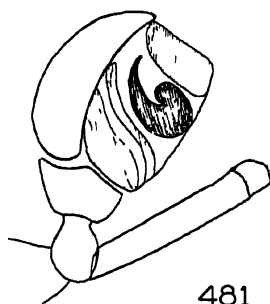
478



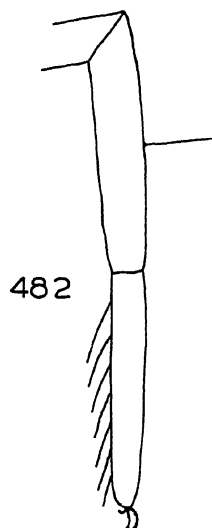
479



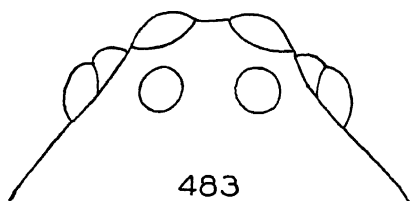
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483

## PLATE LII

FIGURES 484 to 492. *Flegia succini* n. sp. Male. Type. Peabody Museum, Yale University, No. 1.

FIGURE 484. Dorsal view of spider.

FIGURE 485. Side view of head.

FIGURE 486. View of left palp from outside.

FIGURE 487. Spinnerets.

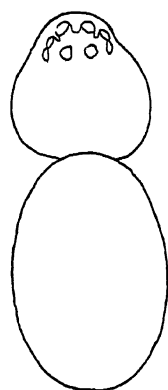
FIGURE 488. Eyegroup viewed from above.

FIGURE 489. Right palp viewed from below. .

FIGURE 490. Ventral view of maxillae, sternum and coxae. The wavy line represents the edge of the white emulsion.

FIGURE 491. Retrolateral view of the end of the first left tarsus, showing the retroclaw, the third claw and two serrated bristles

FIGURE 492. Fourth right tarsus showing the tarsal comb.



484



485

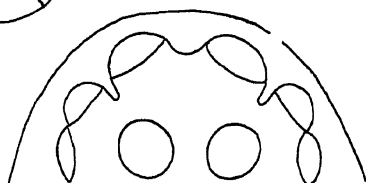


486

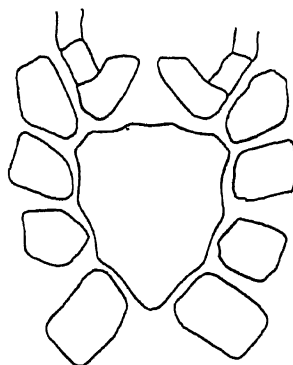
487



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489

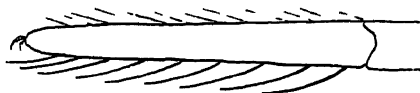


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## PLATE LIII

FIGURES 493 to 498. (?) **Agalena tabida** (Koch and Berendt). Pullus. Cornell University, No. 6.

FIGURE 493. Dorsal view of carapace. The dotted line shows the outline as it would appear if it were visible through the white emulsion.

FIGURE 494. Ventral view of lip, maxillae, sternum and coxae.

FIGURE 495. Left first leg showing general proportions.

FIGURE 496. Front view of face.

FIGURE 497. Ventral view of spinnerets.

FIGURE 498. Claws of second right foot.

FIGURES 499 to 502. **Steatoda succini** n. sp. Immature male. Peabody Museum, Yale University, 3602-a.

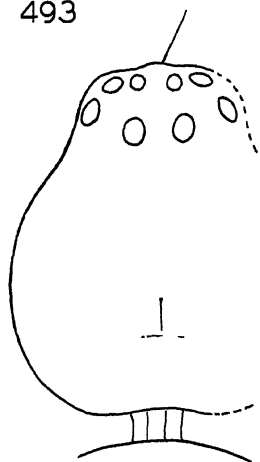
FIGURE 499. Fourth right tarsus showing comb.

FIGURE 500. Spinnerets, colulus and anal tubercle.

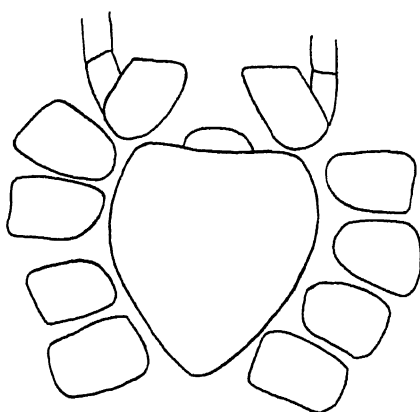
FIGURE 501. Prolateral view of left chelicera.

FIGURE 502. Claws of third right leg.

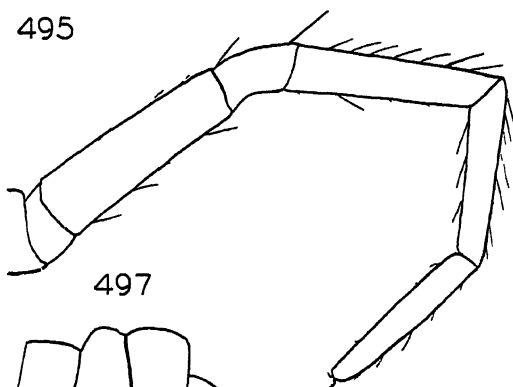
493



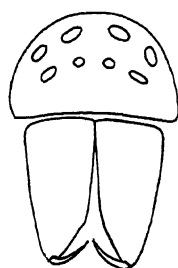
494



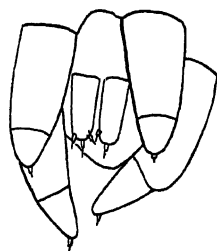
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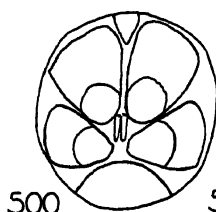
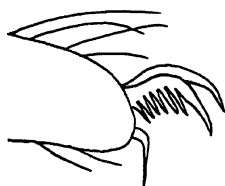
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## PLATE LIV

FIGURE 503. *Steatoda succini* n. sp. Immature malc. Peabody Museum, Yale University 3062-a. Ventral view of lip, maxillae, sternum and coxae.

FIGURES 504 to 509. *Inceptor aculeatus* n. g., n. sp. Pullus. Cornell University No. 5.

FIGURE 504. Prolateral view of fourth right leg showing general proportions and spines.

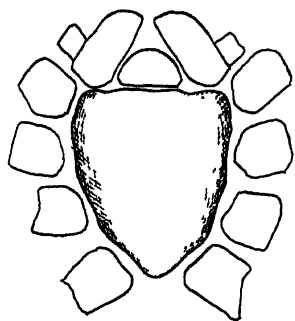
FIGURE 505. Dorsal view of carapace. Part of the eyegroup is obstructed from view by the first right femur.

FIGURE 506. Ventral view of lip, maxillae, sternum and coxae.

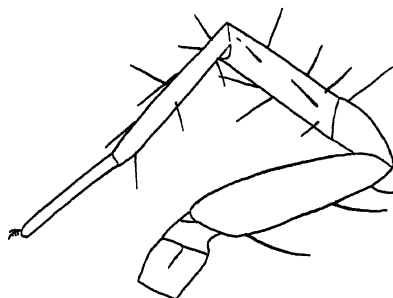
FIGURE 507. Front view of face.

FIGURE 508. Anal tubercle and spinnerets viewed from the right side.

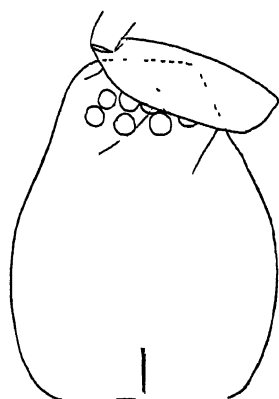
FIGURE 509. Retrolateral view of the claws of the first right tarsus.



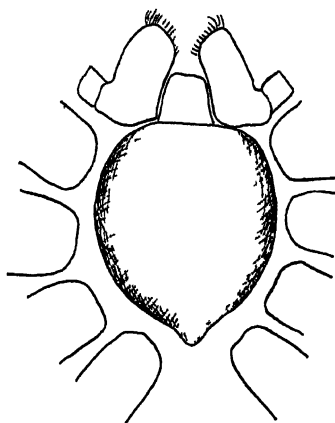
503



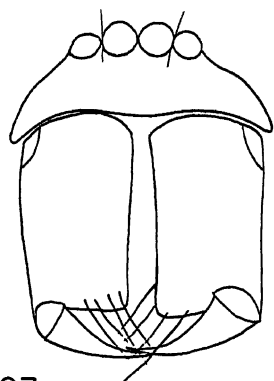
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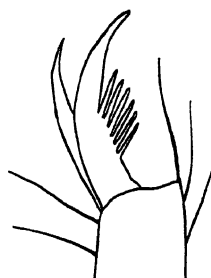
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509

## PLATE LV

FIGURES 510 to 515. **Collacteus minutus** n. sp. Type. Pullus. Peabody Museum, No. 3.

FIGURE 510. Ventral view of lip, maxillae, sternum and coxae.

FIGURE 511. Ventral view of left spinnerets at high magnification. The median spinneret is barely visible between the anterior and posterior spinnerets. Note that spigots are only on anterior spinneret, while common spinning tubes are on median and posterior spinnerets.

FIGURE 512. Dorsal view of spider. Notice remnants of segmentation on abdomen.

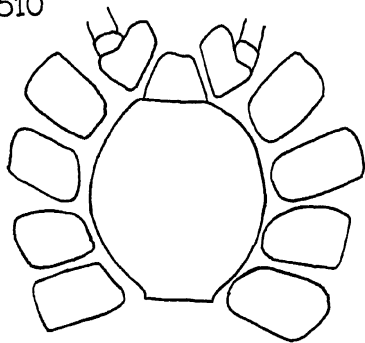
FIGURE 513. Palpal claw.

FIGURE 514. Dorsal membrane at end of fourth left metatarsus.

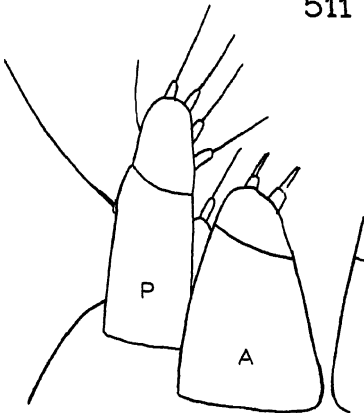
FIGURE 515. Tarsal claws of fourth left leg.

FIGURE 516. **Acrometa cristata** n. g., n. sp. Male. British Museum, Coll. Klebs 510, No. 13461, In. 18752. Claws of second left tarsus. Notice also two spurious claws.

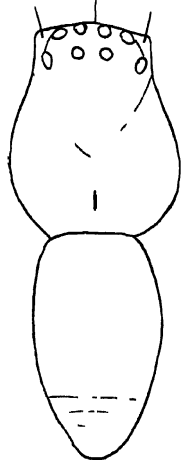
510



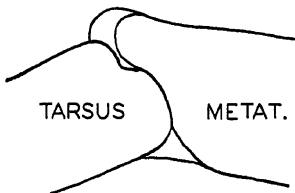
511



512



513



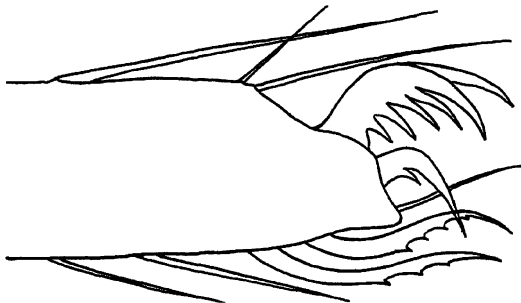
TARSUS

METAT.

514



515



516

PLATE LVI

Photographs

- FIGURE 517. **Gorgopis frenata** (Koch and Berendt). Male.  $\times 4$ . Hypoparatype. Coll. Klebs 511, No. 13432. British Museum In. 18753.
- FIGURE 518. **Gorgopis jucunda** n. sp. Immature female.  $\times 6$ . Coll. Klebs 492, No. 13480. British Museum In. 18735.
- FIGURE 519. **Gorgopis frenata** (Koch and Berendt). Male. Hypotype.  $\times 4$ . Coll. Klebs 496, No. 3773. British Museum In. 18739.
- FIGURE 520. **Gorgopis frenata** (Koch and Berendt). Female.  $\times 4.5$ . Hypoparatype. Coll. Klebs 487, No. 3758. British Museum In. 18730.
- FIGURE 521. **Gorgopis frenata** (Koch and Berendt). Pullus.  $\times 12$ . Sedgwick Museum, University of Cambridge, No. C-6655.
- FIGURE 522. **Parevophrys succini** n. g., n. sp. Male. Type.  $\times 4$ . Sedgwick Museum, University of Cambridge, No. C-6656.
- FIGURE 523. **Cenattus exophthalmicus** n. g., n. sp. Female. Type.  $\times 6$ . Seebohm's bequest. British Museum In. 17617.
- FIGURE 524. **Eolinus succineus** n. g., n. sp. Female. Type.  $\times 4.5$ . Coll. Klebs 520, No. 13478. In. 18762.
- FIGURE 525. **Eolinus succineus** n. g., n. sp. Male. Androtype.  $\times 8$ . Coll. A. Théry. British Museum In. 29126.



517. *G. FRENATA*



518. *G. JUCUNDA*



519. *G. FRENATA*



520. *G. FRENATA*



521. *G. FRENATA*



522. *P. SUCCINI*



523. *C. EXOPHT.H.*



524. *E. SUCCINEUS*



525. *E. SUCCINEUS*



## PLATE LVII

### Photographs

FIGURE 526. **Eolinus theryi** n. sp. Male. Type.  $\times 9$ . Coll. A. Théry. British Museum In. 29169.

FIGURE 527. **Auximus succini** n. sp. Female. Type.  $\times 6$ . Coll. Klebs 484, No. 13463. British Museum In. 18727.

FIGURE 528. **Eolinus theryi** n. sp. Immature male.  $\times 4$ . Specimen presented by Prof. Th. S. Painter. Peabody Museum, Yale University.

FIGURE 529. **Dysdera scobiculata** Menge. Immature female.  $\times 4$ . Coll. Klebs 527, No. 13431. British Museum In. 18769.

FIGURE 530. **Annarius balticus** n. g., n. sp. Female. Type.  $\times 4.3$ . Coll. Klebs 507, No. 13435. British Museum In. 18749.

FIGURE 531. **Eomatachia latifrons** n. g., n. sp. Male. Type.  $\times 4.3$ . Coll. Klebs 494, No. 13433. British Museum In. 18737.

FIGURE 532. **Eomatachia latifrons** n. g., n. sp. Male.  $\times 4$ . Coll. Klebs 495, No. 13442. British Museum In. 18738.

FIGURE 533. **Eomatachia latifrons** n. g., n. sp. Male.  $\times 4$ . Coll. Klebs 490, No. 13396. British Museum In. 18733.



526. EOLINUS THERYI



527. AUXIMUS SUCCINI



528. E. THERYI



529. D. SCOBICUL.



530. A. BALTICUS



531. E. LATIFRONS



532. E. LATIFRONS



533. E. LAT.

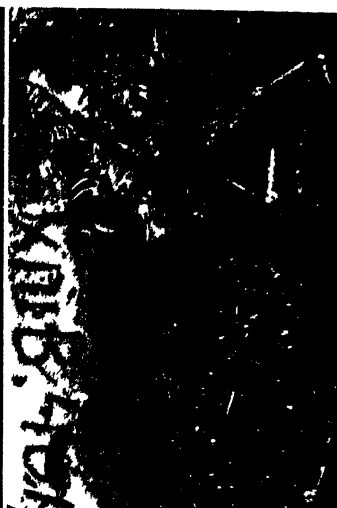
## PLATE LVIII

### Photographs

- FIGURE 534 *Esuritor spinipes* n g n sp Pullus Paratype  $\times 42$   
Coll Klebs 476, No 13400 British Museum In 18718
- FIGURE 535 *Esuritor spinipes* n g, n sp Pullus Type  $\times 43$  Coll  
Klebs 503, No 13401 British Museum In 18745
- FIGURE 536 *Eopopino longipes* n g, n sp Male Type  $\times 33$  Sedg-  
wick Museum, University of Cambridge, No C-6649.
- FIGURE 537 *Ero permunda* n sp Male Type  $\times 53$  Coll Klebs 502,  
No 13462 British Museum In 18744
- FIGURE 538 *Eogonatum minutum* n g n sp Pullus Type.  $\times 24$   
Sedgwick Museum, University of Cambridge, No C-6650
- FIGURE 539. *Captrix lineata* (Koch and Berendt) Female Type.  $\times 43$ .  
Coll Klebs 525, No 13439 British Museum In 18767.
- FIGURE 540 *Municeps pulcher* n g, n sp Pullus  $\times 105$  Seebohm's  
bequest British Museum In 17660



534 ESURITOR SPINIPES



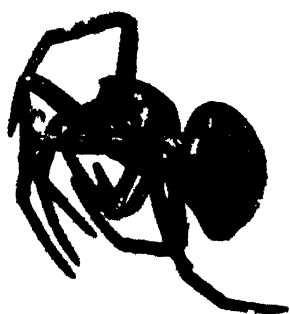
535. E SPINIPES



536 EOPOPINO LONGIPES



537 ERO PERMUNDA



538. E MINUTUM



539. C LINEATA



540. M PULCHER

## PLATE LIX

### Photographs

- FIGURE 541. *Acrometa cristata* n. g., n. sp. Male. Paratype.  $\times 5$ .  
Coll. Klebs 510, No. 13461. British Museum In. 18752.
- FIGURE 542. *Acrometa cristata* n. g., n. sp. Male. Paratype.  $\times 4.3$ .  
Coll. Klebs 485, No. 13458. British Museum In. 18728.
- FIGURE 543. *Acrometa cristata* n. g., n. sp. Male. Paratype.  $\times 4.3$ .  
Coll. Klebs 508, No. 13453. British Museum In. 18750.
- FIGURE 544. *Acrometa cristata* n. g., n. sp. Male.  $\times 8$ . Coll. Samland,  
British Museum In. 17845.
- FIGURE 545. *Acrometa cristata* n. g., n. sp. Male. Type.  $\times 8$ . Coll.  
Klebs 481, No. 13408. British Museum In. 18724.
- FIGURE 546. *Acrometa cristata* n. g., n. sp. Male. Paratype.  $\times 8$ . Coll.  
Klebs 467, No. 13430. British Museum In. 18713.
- FIGURE 547. *Orchestina baltica* n. sp. Female.  $\times 9.3$ . Coll. A. Théry,  
British Museum In. 29132-A.
- FIGURE 548. *Orchestina baltica* n. sp. Male. Androtype.  $\times 12.5$ . Coll.  
Samland, British Museum In. 18138.
- FIGURE 549. *Orchestina baltica* n. sp. Female. Gynetype.  $\times 10.3$ . Coll.  
Samland, British Museum In. 18137.
- FIGURE 550. *Orchestina baltica* n. sp. Female.  $\times 7.3$ . Coll. Samland,  
British Museum In. 18947.
- FIGURE 551. *Theridiometa edwardsi* n. g., n. sp. Female. Type.  $\times 6.3$ .  
Coll. W. N. Edwards, British Museum In. 18964.
- FIGURE 552. *Adorator samlandicus* n. g., n. sp. Male. Type.  $\times 3.7$ .  
Coll. Samland, British Museum In. 18144.



541. A. CRISTATA



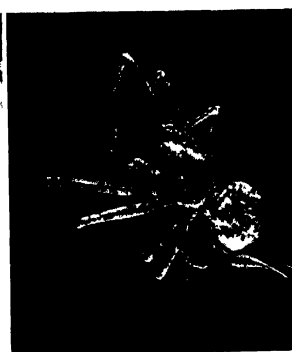
542. A. CRISTATA



543. A. CRISTATA



544. A. CRISTATA



545. A. CRISTATA



546. A. CRISTATA



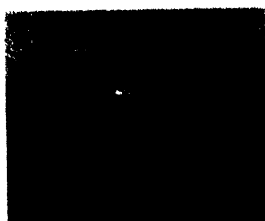
547. O. BALTICA



548. O. BALTICA



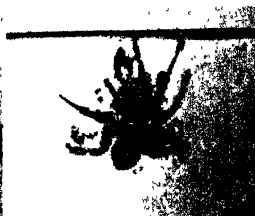
549. O. BALTICA



550. O. BALTICA



551. T. EDWARDSI



552. A. SAMLAND.

## PLATE I \

### Photographs

FIGURE 553 *Adorator brevipes* n s, n sp Male Type  $\times 7$  Coll  
Klebs 474, No 13455 British Museum In 18716

FIGURE 554 *Malleator niger* n g, n sp Male Type  $\times 63$  Coll  
Samland British Museum In 18944

FIGURE 555 *Theridiometa edwardsi* n g, n sp Female Paratype  
 $\times 53$  Coll Klebs 526, No 13417 British Museum In 18768

FIGURE 556 *Custodela cheiracantha* (Koch and Berendt) Male Hypo-  
type  $\times 4$  Coll Klebs 523 No 13425 British Museum In 18765

FIGURE 557 *Ero carboneana* n sp Male Type  $\times 4$  Coll Klebs 513,  
No 13398 British Museum In 18755

FIGURE 558 *Eluctus inermis* n s, n sp Male Type  $\times 7$  Coll  
Klebs 501, No 13441 British Museum In 18743

FIGURE 559 *Insecutor mandibulatus* n sp Immature female Paratype  
 $\times 4$  Coll Klebs 478 No 13434 British Museum In 18721



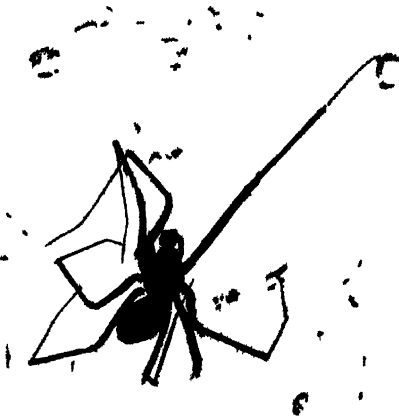
553 A BREVIPES



554 M. NIGER



555 T EDWARDSI



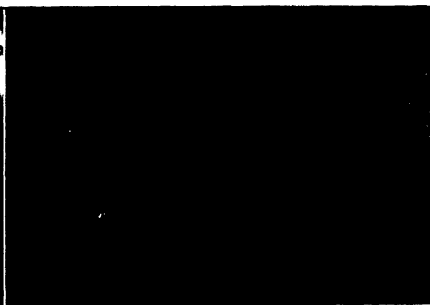
556. C CHEIRACANTHA



557 E CARBONEANA



558. E INERMIS



559 I. MANDIBULATUS



## PLATE LXI

### Photographs

- FIGURE 560. **Insecutor aculeatus** n. g., n. sp. Immature female. Type.  $\times 65$ . Coll. Klebs 499, No. 13465. British Museum In. 18741.
- FIGURE 561. **Abliguritor niger** n. g., n. sp. Male. Type.  $\times 43$ . Coll. Samland, British Museum In. 18119.
- FIGURE 562. **Segestria elongata** (Koch and Berendt). Female.  $\times 5.8$ . Coll. Klebs 475, No. 13445. British Museum In. 18717.
- FIGURE 563. **Insecutor mandibulatus** n. sp. Immature female.  $\times 5.5$ . Coll. Klebs 482, No. 3775. British Museum In. 18725.
- FIGURE 564. **Insecutor aculeatus** n. g., n. sp. Immature female. Paratype  $\times 4$ . Coll. Klebs 480, No. 13447. British Museum In. 18723.
- FIGURE 565. **Eodipoena oculata** n. g., n. sp. Female. Type.  $\times 4.3$ . Coll. Klebs 498, No. 13448. British Museum In. 18740.
- FIGURE 566. **Archaea paradoxa** (Koch and Berendt). Immature female.  $\times 22$ . Coll. Klebs 500, No. 13874. British Museum In. 18748.



560. I. ACULEATUS



561. A. NIGER



562. S. ELONGATA



563. I. MANDIBULATUS



564. I. ACULEATUS



565. E. OCULATA



566. A. PARADOXA

## PLATE LXII

### Photographs

- FIGURE 567. *Eustaloides succini* n. sp. Male. Type.  $\times 4.3$ . Coll. Klebs 522, No. 13438. British Museum In. 18764.
- FIGURE 568. *Segestria elongata* (Koch and Berendt). Female.  $\times 4.7$ . Coll. Klebs 493, No. 13415. British Museum In. 18736.
- FIGURE 569. *Spatiator praeceps* n. g., n. sp. Female. Gynetype.  $\times 6.3$ . Coll. Klebs 518, No. 3761. British Museum In. 18760.
- FIGURE 570. *Adulatrix rufa* n. g., n. sp. Female.  $\times 4$ . Coll. Klebs 517, No. 13413. British Museum In. 18759.
- FIGURE 571. *Adulatrix fusca* n. g., n. sp. Immature female. Type.  $\times 4$ . Coll. Klebs 491, No. 13412. British Museum In. 18734.
- FIGURE 572. *Desultor depressus* n. g., n. sp. Male. Type.  $\times 4$ . Coll. Klebs 514, No. 13411. British Museum In. 18756.



567. T. SUCCINI



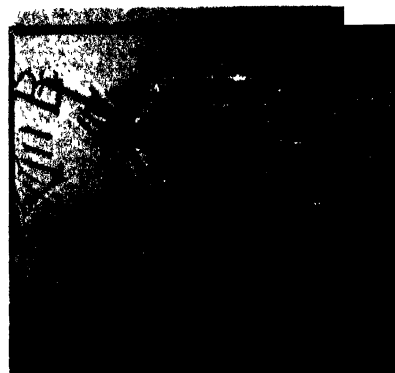
568. S. ELONGATA



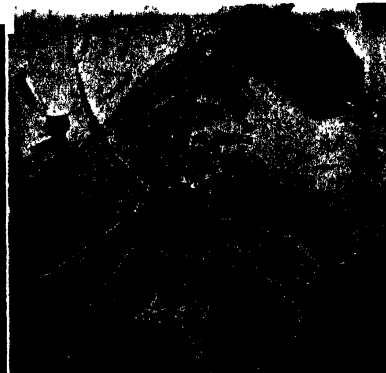
569. S. PRAECEPT



570. A. RUFA



571. A. FUSCA



572. D. DEPRESSUS

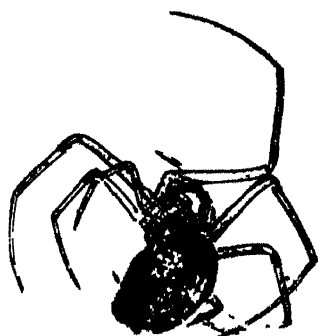
## PLATE LXIII

### Photographs

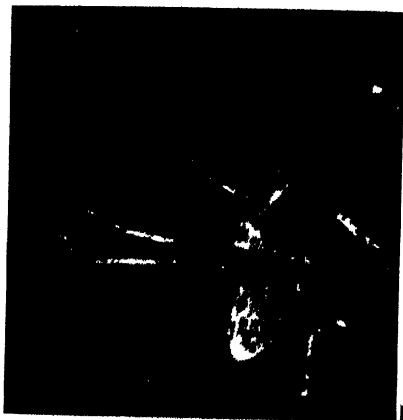
- FIGURE 573. *Adulatrix fusca* n. g., n. sp. Female. Paratype.  $\times 57$ .  
Coll. Klebs 483, No. 13406. British Museum In. 18726.
- FIGURE 574. *Meditrina circumvallata* n. g., n. sp. Female. Type.  $\times 86$ .  
Coll. Samland, British Museum In. 18159.
- FIGURE 575. *Adulatrix decumana* (Koch and Berendt). Female.  $\times 3$ .  
Coll. Klebs 512, No. 13402. British Museum In. 18754.
- FIGURE 576. *Massula klebsi* n. g., n. sp. Male. Paratype.  $\times 6$ . Coll.  
Klebs 477, No. 13408. British Museum In. 18720.
- FIGURE 577. *Adulatrix rufa* n. g., n. sp. Immature female. Type.  $\times 43$ .  
Coll. Klebs 488, No. 13440. British Museum In. 18731.
- FIGURE 578. *Spatiator praeceps* n. g., n. sp. Male. Androtype.  $\times 43$ .  
Coll. Klebs 519, No. 3764. British Museum In. 18761.



573. A. FUSCA



574. M. CIRCUMVALLATA



575. A. DECUMANA



576. M. KLEBSI



577. A. RUFA



578. S. PRAECEPT

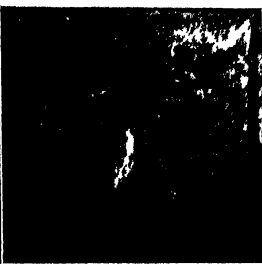
# PLATE LXIV

## Photographs

- FIGURE 579 **Collacteus captivus** n g n sp Female Type \ 4  
Coll Klebs 472 No 13414 British Museum In 18714
- FIGURE 580 **Massula klebsi** n g n sp Male Type X 47 Coll  
Klebs 504 No 13486 British Museum In 18746
- FIGURE 581 **Adamator succineus** n g, n sp Female Type \ 4  
Coll Klebs 486 No 13404 British Museum In 18729
- FIGURE 582 **Ablator triguttatus** (Koch and Brendt) Male \ 4  
Coll Klebs 524 No 13409 British Museum In 18766
- FIGURE 583 **Syphax crassipes** n sp Immature male Type \ 43  
Coll Klebs 479 No 13449 British Museum In 18722
- FIGURE 584 **Myro fossilis** n sp Female Type X 4 Coll Samland,  
British Museum In 18115
- FIGURE 585 **Adjunctor similis** n g n sp Female Type X 63 Coll  
Samland British Museum In 18085
- FIGURE 586 **Admissor aculeatus** n g n sp Female Type X 73  
Coll Samland British Museum In 18946
- FIGURE 587 **Theridiometa edwardsi** n g n sp Pullus \ 67 Coll  
Samland British Museum In 18121



579 C CAPTIVUS



580 M KLEBSI



581 A SUCGINEUS



582 A TRIGUTTATUS



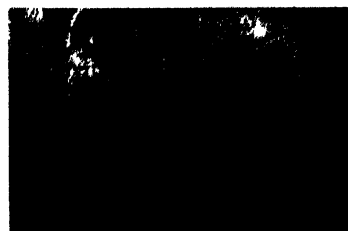
583 S GUTTAT



584 M FOSSIL



585 A SIMILIS



586 A ACULEATUS



587 T EDWARDSI



## PLATE LXV

### Photographs

FIGURE 588. **Theridiometa samlandica** n. g., n. sp. Exuvium.  $\times 6$ .  
Seebohm's bequest, British Museum In. 17629.

FIGURE 589. **Memoratrix rydei** n. g., n. sp. Female. Type.  $\times 4$ . Coll.  
C. Ryde, British Museum In. 27369.

FIGURE 590. **Eustaloides setosus** n. sp. Male. Type.  $\times 5.3$ . Coll. Sam-  
land, British Museum In. 18117.

FIGURE 591. **Eomysmena moritura** n. g., n. sp. Male. Type.  $\times 6.3$ .  
Coll. Samland, British Museum In. 18113.

FIGURE 592. **Obnisus tenuipes** n. g., n. sp. Male. Type.  $\times 8$ . Coll.  
Samland, British Museum In. 18116.

FIGURE 593. **Mystagogus glaber** n. g., n. sp. Male. Type.  $\times 7$ . Coll.  
Samland, British Museum In. 18125.



588. *T. SAMLANDICA*



589. *M. RYDEI*



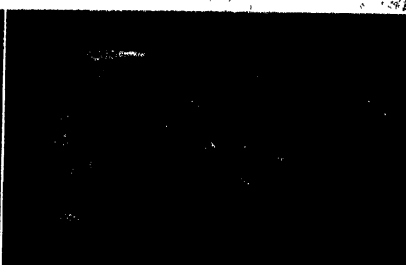
590. *E. SETOSUS*



591. *E. MORITURA*



592. *O. TENUIPES*



593. *M. GLABER*

## PLATE LXVI

### Photographs

- FIGURE 594 *Theridiometa samlandica* n g n sp Immature female  
×7 Coll Samland British Museum In 18132
- FIGURE 595 *Eogonatum succini* n sp Female Type ×13 Coll  
Samland, British Museum In 18943
- FIGURE 596 *Eostasina aculeata* n g n sp Female Type ×2 Coll  
Samland British Museum In 18111
- FIGURE 597 *Amaurobius succini* n sp Type Exuvium ×29 Coll  
Samland British Museum In 18160
- FIGURE 598 *Ablator triguttatus* (Koch and Beier) Male Hypotype  
×4 Coll Klebs 509 No 13426 In 18751
- FIGURE 599 *Insecutor mandibulatus* n g n sp Female Type ×37  
Coll Klebs 500 No 13456 British Museum In 18742
- FIGURE 600 *Insecutor rufus* n g n sp Female Type ×63 Coll  
Samland British Museum In 18123



594 T SAMLANDICA



595 E SUCCINI



596 E ACULEATA



597 A SUCCINI



598 A TRIGUT



599 I MANDIBUL



600 I RUFUS

## PLATE LXVII

### Photographs

FIGURE 601. **Myro hirsutus** n. sp. Male. Type.  $\times 10$ . Coll. Samland, British Museum In. 18907.

FIGURE 602. **Arthrodictyna segmentata** n. g., n. sp. Pullus. Type  $\times 17$ . Coll. Samland, British Museum In. 18950.

FIGURE 603. **Liticen setosus** n. g., n. sp. Male. Type.  $\times 8$ . Coll. Samland, British Museum In. 18118

FIGURE 604. **Adulatrix parva** n. g., n. sp. Female.  $\times 7$ . Type. Coll. Samland, British Museum In. 18124.

FIGURE 605. **Impulsor neglectus** n. g., n. sp. Male. Type.  $\times 6$ . Coll. Samland, British Museum In. 18122.

FIGURE 606. **Eomysmena succini** n. g., n. sp. Male. Type.  $\times 21$ . Coll. Samland, British Museum In. 18114.

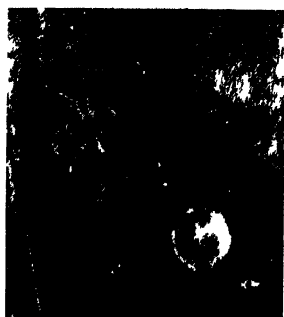
FIGURE 607. **Adjutor mirabilis** n. g., n. sp. Immature female. Type.  $\times 20$ . Coll. Samland, British Museum In. 18945.



601. M. HIRSUTUS



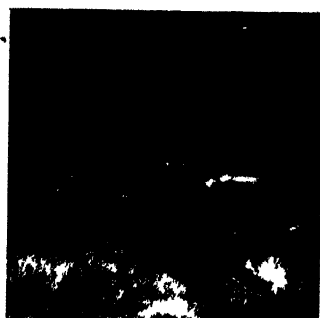
602. A. SEGMENTATA



603. L. SETOSUS



604. A. PARVA



605. I. NEGLECTUS



606. E. SUCCINI



607. A. MIRABILIS

## PLATE LXVIII

### Photographs

FIGURE 608. **Gorgopis jucunda** n. sp. Female. Type  $\times 8$ . Coll. Klebs 516, No. 3765. British Museum In. 18758.

FIGURE 609. **Gorgopis jucunda** n. sp. Chitinous portion of lip, sternum, maxillae and coxae  $\times 17$ . Coll. Klebs 505, No. 3768. British Museum In. 18747.

FIGURE 610. **Gorgopis jucunda** n. sp. Chitinous portion of maxilla with serrula.  $\times 400$ . Coll. Klebs 505, No. 3768. British Museum In. 18747.

FIGURE 611. **Medela baltica** n. g., n. sp. Female. Type.  $\times 14$ . Coll. Samland, British Museum In. 18139-A.

FIGURE 612. **Filiola argentata** n. g., n. sp. Female. Type.  $\times 20$ . Coll. Samland, British Museum In. 18139-B.

FIGURE 613. **Miropholcus heteropus** n. g., n. sp. Immature male. Type.  $\times 16$ . Coll. Samland, British Museum In. 18139-C.

FIGURE 614. **Facundia clara** n. g., n. sp. Immature female. Type.  $\times 14$ . Coll. Samland, British Museum In. 18127.

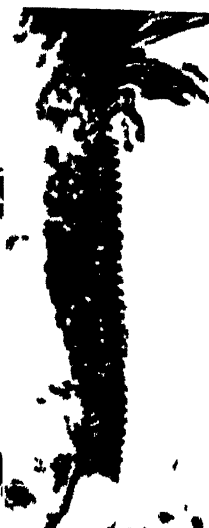
FIGURE 615. **Misumena samlandica** n. sp. Female. Type.  $\times 66$ . Coll. Samland, British Museum In. 18120.



608. G. JUCUNDA



609. G. JUCUNDA



610. G. JUCUNDA



611. M. BALTICA



612. F. ARGENTATA



613. M. HETER.



614. F. CLARA



615. M. SAMLANDICA



## PLATE LXIX

### Photographs

- FIGURE 616. *Paralinus crosbyi* n. g., n. sp. Male. Type.  $\times 6.6$ . Coll. C. R. Crosby, Cornell University, No. 1.
- FIGURE 617. *Eodipoena bassleri* n. g., n. sp. Female. Type.  $\times 4$ . Coll. R. S. Bassler, U. S. Nat. Museum.
- FIGURE 618. *Paruroctea blauvelti* n. g., n. sp. Female. Type.  $\times 6.6$ . Coll. R. S. Crosby, Cornell University, No. 2.
- FIGURE 619. *Caduceator minutus* n. g., n. sp. Pullus. Type.  $\times 6$ . Peabody Museum, Yale University, No. 3.
- FIGURE 620. *Agalena tabida* (Koch and Berendt). Pullus.  $\times 9.3$ . Coll. C. R. Crosby, Cornell University, No. 6.
- FIGURE 621. *Theridiometa robusta* n. sp. Pullus. Type.  $\times 10$ . Coll. C. R. Crosby, Cornell University, No. 8.
- FIGURE 622. *Steatoda succini* n. sp. Female. Type.  $\times 10.5$ . Coll. C. R. Crosby, Cornell University, No. 3.
- FIGURE 623. *Steatoda succini* n. sp. Immature male.  $\times 6.6$ . Peabody Museum, Yale University, No. 3602-A.
- FIGURE 624. *Flegia succini* n. sp. Male. Type.  $\times 6$ . Peabody Museum, Yale University, No. 1.
- FIGURE 625. *Inceptor aculeatus* n. g., n. sp. Pullus.  $\times 10$ . Coll. C. R. Crosby, Cornell University, No. 5.
- FIGURE 626. *Orchestina baltica* n. sp. Female.  $\times 10$ . Coll. C. R. Crosby, Cornell University, No. 4.
- FIGURE 627. *Nactodipoena dunbari* n. g., n. sp. Male. Type.  $\times 10$ . Peabody Museum, Yale University, No. 2.



616. P. CROSBYI



617. E. BASS.



618. P. BLAUVELTI



619. C. MINUTUS



620. A. TABIDA



621. T. ROBUSTA



622. S. SUCC.



623. S. SUCC.



624. FLEGIA SUCCINI



625. I. ACULEATUS



626. Q. BALT.



627. N. DUNBARI



